#27

Errata Sheet
for
Manuscript Form
Technical Manual
for
RADIO SETS
AN/GRN-9, AN/GRN-9A, AN/SRN-6
and
ASSOCIATED ANTENNA GROUPS

This errata sheet covers typographical and editorial errors found to exist in this manual. Using personnel are requested to make the changes indicated on the errata sheet in the proper places of the manual before discarding the errata sheet.

The following is a list of the corrective changes.

Page	Par.	Line	Change
1-4	2b(1)(b)4	3	"when headed toward" to read "relative to"
1-25	10a	14	"-357 v" to read "-375 v"
2-3		5	"135" to read "15"
2-7	1g	13	delete "a-c, for 120-volt a-c, "
2-9	2b, 3rd par.	1	"V304" to read "V305"
2-10	2nd par.	3	"C303" to read "C308"
2-11	2d	7	delete "and at J503"
2-14	3a	17	"triode V601A" to read "triode V609A"
2-15		2	"V605 after passing" to read "V606 after passing"
2-16	3c	22	"135" to read "15"
2-17	3e, 2nd par.	2	2nd sentence to read "The output of V615 consists of 1.5-microsecond pulses."
		4	"positive" to read "negative"
		5	"cathode" to read "grid"
2-21		6	"R791" to read "R788"
2-22	4a, 2nd par.	6	"pin 7" to read "pin 3"
2-24	6th par.	1 & 2	"at X and XI. L1531 and L1532 are r-f chokes" to read "through r-f chokes Z1531 and Z1532".

Page	Par.	Line	Change
2-26	1st par.	7 & 8	to read "at the input of T1402 are reduced"
	4th par.	2	"V1409" to read "V1407"
2-27	4d	1	"V1401" to read "V1410"
2-31	3rd par.	2	to read "The resistor and coil in Z1301 form a high-frequency parasitic"
		4	delete "R1302 in parallel with inductance L1302" and substitute "Z1302"
2-37		2	"R1456" to read "R1466"
	6d	1	"V1401" to read "V1410"
	6e, 2nd par.	7	"R1456" to read "R1460"
		10	"C1407" to read "C1418"
2-38	2nd par.	2	"7.5 kw" to read "11 kw"
		6	"Z1165" to read "Z1156"
2-39	8e, 2nd par.	2	"P1152" to read "P1162"
2-40	9a(1)	7	"reflectors are" to read "directors are"
2-42	9b(4)	6	"command" to read "reference"
2-46	9c(3)(b)3	6 & 7	to read "shown in figure 2-29.9. The 1-speed synchro is rezeroed to set the crossover point at 0° as shown in figure 2-29.10. Note that the other position"
2-49	9d(2)(a)	3	delete "phase-sensitive"
2-52	9f (2)(d)	5	"2-29.23" to read "2-29.21"
	9f (2)(e)	6	"8" to read "10"
		7	"10" to read "8"
2-53	9f (3)(a)	12	"(figure 2-87)" to read "(figure 2-29.25)"
2-56	9h(2)(b)1, 2nd par.	2, 3 & 4	to read "acts as a capacitance, causing a leading current proportional to the frequency difference. If the incoming frequency is below the norm, the circuit has an inductive effect on the signal with opposite (or lagging) phase difference."
2-57	9h(2)(b)3, 3rd par.	2	to read "Rectifiers CR2109, CR2110, CR2122 and CR2123 establish the d-c bias voltage"
2-59	9i (3)	11	delete "for both positive feedback and"
		12	delete "and bias"
2-61	last par.	3	"V627" to read "V705"
		6	delete "R703, R704 and"
2-65	10e	7	"K801" to read "K1901"

Page	Par.	Line	Change
2-66		4	"M1901" to read "M1902"
	5th par.	7	"200 ma" to read "250 ma"
	6th par.	8	"R1914" to read "R1916"
2-67	10f after (3)		Insert "(4) The overload relay K1904 is set to trip when the load current equals 125 ma."
	11e(2)		"S1104" to read "S701"
	11e(3)		to read "TEST SET ON switches on each unit of test equipment energizing the test set circuits."
2-68	11e after (3)		Insert "(4) Phase failure detection relays K901 and K902 are energized."
2-69	11j	2	to read "K1801, which connects 120 VAC to the +700V, +1,000V lamp DS1801."
		3	Delete the entire line.
2-70	11k(3)	1	to read "light DS1902 (HV READY) is lit, signifying that"
	11k(5)		"S1111" to read "S1902"
2-76	12h(1)	1	"2-33" to read "5-1"
2-77	12h(2)	1	"2-33" to read "5-1"
2-79	12h(3)	2	"2-33" to read "5-1"
3-12	5b CAUTION	2	"116, 117, and 118" to read "4, 5, and 6"
3-36	15c(5)	2	"R437" to read "R427"
3-36	16a(1)	1	"POWER" to read "CODER INDICATOR OFF-ON'
3-43	18a(4)	1	"S1901" to read "S1902"
3-44	18a(10)	1	"S1901" to read "S1902"
4-11	Step 9	2	"(S1901)" to read "(S1902)"
	Fig. 4-4		"E601 and E602" to read "S601 and S602"
5-5	HOW TO CHECK	1	"low-voltage" to read "medium-voltage"
5-12	Step 10	2	"93db" to read "-93DBM"
	Step 12	3	"93db" to read "-93DBM"
	Step 13	3	"93db" to read "-93DBM"
5-19 & 5-20			Remove page and replace with pages 5-19, 5-20, 5-21, and 5-21A supplied with this errata sheet.
5-21			Delete entire page.

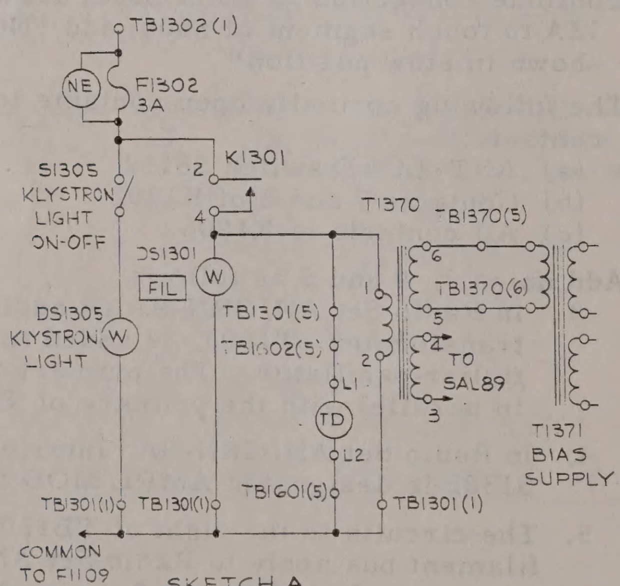
Page	Par.	Line	Change
6-11	2c(1) Note	last	"35 db" to read "-35 DBM"
6-12	2c(9)	5	"93 db" to read "-93 DBM"
	2c(12)	3	"93 db" to read "-93 DBM"
6-13	2f(3)	1	insert to read "is 6 auxiliary"
6-16	2 1(4)	4-5	change to read "so that the pulses from the TS-890/URN-3 are slightly larger in amplitude than the pulses from the frequency multiplier-oscillator."
6-17	3	3&4	delete sentence
6-17 through 6-21	3a through 3h		delete
7-7	1e, 4th col.	1	"1 or 2" to read "1, 2 or 3"
		7	"3 or 4" to read "4 or 5"
7-8	2b, 3rd col.	10	"7-7" to read "7-13"
7-9	3b, 2nd col.	1, 2&3	delete "duplexer. See paragraph 10" and substitute to read "check tuning of preselector Z1153."
	3b(1), 4th col.	1	"duplexer" to read "preselector"
		4	"paragraph 10" to read "Section 3, paragraph 12 b."
	3b(2), 4th col.	1	"duplexer" to read "preselector"
		4	"duplexer" to read "preselector"
7-10	4c, 2nd col.	3	"10c(7)" to read "13c"
7-11	5b, 4th col.	3 & 4	"antenna" to read "coder-indicator"
		5	delete "chart"
		5	"9b(4)" to read "13h"
	5c, 4th col.	2	delete "chart"
		2	"9a" to read "9b(3)."
	5d, 4th col.	3	"9b(3)" to read "9c."
7-13	6a(1), 2nd col.	3	"10" to read "13e."
	6a(1), 4th col.	5	"10" to read "13e."
	7a, 2nd col.	6	"paragraph 10" to read "Section 6, paragraph 2h"
7-22	1a, 3rd col.	1	insert to read "a. In Radio Sets AN/GRN-9 and AN/GRN-9A check"
		2	insert "In Radio Set AN/SRN-6 check fuses F1101, F1102 and F1103."

Page	Par.	Line	Change
7-26	1a, 2nd col.	3	"paragraph 10" to read "Section 6, paragraph 2c."
7-26	1b, 2nd col.	4	"10" to read "12 i"
	1b (1)(d), 4th col.	2	"8 below" to read "7"
7-27	1b(3)(b), 4th col.	2	"8 below" to read "7"
	1c(3), 4th col.	1	"antenna duplexer" to read "preselector"
		2&3	"paragraph 10" to read "table 3-4 in Section 3."
7-28	2a, 2nd col.	5	"DS1501" to read "DS501"
	2a, 3rd col.	3	"DS1501" to read "DS501"
7-30	3b, 4th col.	7	"10" to read "12c."
7-43	2, 3rd col.	2	"7b" to read "7a(2)"
7-46	3, 2nd col.	1	"9" to read "10"
	3, 3rd col., 1st par.	10	delete "and DL1403"
	3rd par.	2 to 6	delete all after "width,"
		2	insert to read "incorrect width, refer to paragraph 14a(3)."
7-48	1b, 3rd col.	5	"10" to "14a(2)."
7-49	3b, 3rd col.	3	"10" to "Section 3, paragraph 14a."
	3c, 3rd col.		delete
7-53	8b	2&3	"paragraph 10" to read "Section 3, paragraph 14"
	8c		delete 1st paragraph
7-55	1b, 3rd col.	5	"10" to read "14"
7-59	1, 2nd col.	2	"I1402" to read "DS1402"
		3	"I1403" to read "DS1403"
	1b, 4th col.	4	insert to read "check fuses F1004 and F1005."
7-60	2a(1), 4th col.	3	insert to read "and F1106 in Radio Set AN/SRN-6 and F1001, F1002, and F1003 in Radio Sets AN/GRN-9 and AN/GRN-9A."
7-61	2b(2), 4th col.	1	insert to read "(2) In Radio Sets AN/GRN-9 and AN/GRN-9A, check fuses F901, F902, and F903, and in Radio Set AN/SRN-6, check fuses"

Page	Par.	Line	Change
7-61	2b(3), 4th col.	1	insert to read "In Radio Sets AN/GRN-9 and AN/GRN-9A, check fuses F904, F905 and F906, and in Radio Set AN/SRN-6, check fuses"
7-62	2b(4), 4th col.	1	insert to read "In Radio Sets AN/GRN-9 and AN/GRN-9A, check fuses F1007, F1008, and F1009. In Radio Set AN/SRN-6, check fuses"
7-68	6, 2nd col.	3	"I1601" to read "DS1601"
7-79	2, 3rd col.	3	"168 and 169" to read "3 and 5"
7-86	2a, 3rd col.	3	"TP902" to read "TB902"
7-93	11d (1)	3	to read "to trip at 250 ma in Power Supply PP-1764/URN and 125 ma in Power Supply PP-1763/URN. Normal full load current is approximately 200 ma in Power Supply PP-1764/URN and 90 ma in Power Supply PP-1763/URN, which"
7-103	13b(10)	3	"north and auxiliary bursts are" to read "1, 350-cps tone oscillator is"
		4	delete "Replace plug P905 in J604 and"
		5	add to read "drawer and return BATTLE SHORT switch to NOR."
	13b(3)	5	"7-9" to read "7-13"
7-110	14a(3)(a)1	2&3	to read "the GENERAL TEST position, to the ANTENNA INCIDENT jack on the control-duplexer, and observe the north reference burst."
	14a(3)(a)3	2	delete "approximately"
7-112	14b(3)(a)3	1	"1464" to read "1465"
7-121	15c(1)(c) 15c(1)(d)	1 1	delete "(31)" delete "(31)"
7-122	15c(3)(c)1	1	delete "(43)" and "(47)"
7-123	15c(6)	1	insert "(See figure 7- 39. 29. 2.)"

Figure	Change
2-1	At arrow leading from the inner portion of ANTENNA GROUP, change "135" to read "15."
2-3	Bottom line joining resistors is +150V REG supply bus.
2-5	Delete line between R327 and R328. Continue R327 to a testpoint, "TP3," continue R328 to an arrow marked"+150V"
2-11	"-150 VDC REG" to read "-105 VDC REG"
2-22	"1200 Volt KLYSTRON GATE" to read 12,000 VOLT KLYSTRON GATE"
2-22.1	To the right of the 6th waveform, insert "KEYING PULSES ON FIRST AND SECOND RF AMPLIFIER CATHODES"
2-24	Change in caption: "CV589" to read "CV590"
2-29.23	On T2111 terminals: change "6" to "7;" "7" to "6;" "8" to "10;" "10" to "8"
	Add a line from terminal 9 on T2111 to the junction of the two bridge rectifiers.
2-30.1	"C2102" to read "C2101"
	Reverse the polarity of CR1.
2-30.4	Reverse the polarity of CR2023.
2-30.8	Continue connection to 4B of S606; draw rotor arrow from 12A to touch segment of S606; add "NOTE Switch S606 shown in stow position"
7-24	The following normally open contacts to normally closed contacts; (a) ANT-LOAD switch S6152 (b) Contacts 7 and 8 of K1902 (c) All contacts of K1806.
7-24	Add notes 3, 4 and 5 as follows: 3. In Radio Set AN/GRN-9A an additional filament transformer, T1503, is added in the frequency multiplier-oscillator. The primary of T1503 is connected in parallel with the primary of T1501. 4. In Radio Set AN/GRN-9A, interlock switch AMPL MOD S1302 is designated AMPL MOD S1371. 5. The circuits to the right of TB1302 (1) on the regulated filament bus apply to Radio Set AN/GRN-9 only. Refer to the attached sketch A for circuits employed in Radio Set AN/GRN-9A.

Figure	Change
7-24. 1	the following normally open contacts to normally closed contacts: (a) ANT-LOAD switch S6152 (b) Contacts 7 and 8 of K1902 (c) All contacts of K1806 amperage rating of F1004 and F1005 to 8A. amperage rating of F913, F914, and F915 to 1A. add transformer T1503 with primary winding in parallel with T1501. fuses F1114, F1115, and F1116 to read F1014, F1015, and F1016 and change rating of these fuses from 3A to 2A. interlock switch AMPL MOD S1302 to read AMPL MOD S1371. the circuits to the right of TB1302 (1) on the regulated filament bus to agree with the attached sketch A.



SKETCH A
ADDITION TO FIGURE 7-24 & 7-24.1

NAVSHIPS 92986 (VOL. 1)

MANUSCRIPT FORM

TECHNICAL MANUAL

for

RADIO SETS AN/GRN-9, AN/GRN-9A, AN/SRN-6 and Associated Antenna Groups

THIS VOLUME CONTAINS SECTIONS 1 THRU 6 INCLUSIVE VOLUME 2 CONTAINS SECTION 7 VOLUME 3 CONTAINS SECTION 8

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LIST OF EFFECTIVE PAGES

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i to xxi	Original	5-1 to 5-27	Original
1-1 to 1-45	Original	6-1 to 6-25	Original
2-1 to 2-80	Original		

NOTE

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SECTION 1

GENERAL DESCRIPTION

1. INTRODUCTION.

a. This instruction book provides the general description, theory of operation, and instructions for the installation, operation, and maintenance of radio beacon equipments (figure 1-1) constituting the shore-based and shipboard installations of a tactical air communication and navigation (Tacan) system.

b. The specific equipments covered in this instruction book are:

(1) RADIO SET AN/GRN-9. - This set employs a type SAL-39A (low-power, 5-kw) klystron in the transmitter output stage, and is designed for shore installations. It includes the necessary antenna group and accessories.

(2) RADIO SET AN/GRN-9A. -This set employs a type SAL-89 (high-power, 7.5-kw min.) klystron in the transmitter output stage, and is designed for shore installations. It also includes the necessary antenna group and accessories.

(3) RADIO SET AN/SRN-6. - This set also employs a type SAL-89 klystron in the transmitter output stage, but is designed for shipboard installations. It includes the necessary antenna group and accessories, plus the facilities required to compensate, on shipboard, for roll, pitch and bearing variations.

c. The components of the three types of radio beacon equipment mentioned above are listed in tables 1-1 through 1-3, respectively.

d. These three types of equipment are very similar. They differ mainly in the transmitter output power, the type of antenna group used, and the primary power distribution circuitry. Therefore, unless specifically stated to the contrary, the discussions and procedures given in this instruction book will apply equally to all three.

2. BASIC PRINCIPLES.

a. INFORMATION SUPPLIED BY RADIO BEACON. - The radio beacon supplies to the aircraft the information it requires to determine its geographic position. The information elements supplied are listed below in the order of

the priority established for each within the beacon. Each is analyzed briefly in paragraphs 2b through 2d, below.

(1) Angular bearing relative to the radio beacon, referenced to magnetic north.

(2) Radio beacon identification.

(3) Range, or distance from the beacon.

b. BEARING RELATIVE TO THE BEACON.

(1) BEARING INFORMATION COMPONENTS. - The bearing information presented to the pilot is the direction of the beacon with respect to the aircraft, measured in degrees clockwise from magnetic north. This is the "reciprocal" (180° removed) of the information obtained from the "modulated" antenna pattern, which actually shows the direction of the aircraft from the beacon. The bearing information supplied by the beacon is originated by the beacon, and consists of four components, as follows:

(a) 15-CPS AMPLITUDE MODULATION. - A 15-cps amplitude-modulation component is imposed on the r-f energy radiated by the beacon antenna. Figure 1-2 shows how modulation is imposed on the field of r-f energy radiated by the antenna.

1. Figure 1-2A shows a conventional circular antenna pattern. Figure 1-2B shows the same antenna pattern as it is affected when a fixed reflector is placed in the field of energy radiated by the antenna. The pattern becomes a cardioid. The field of r-f energy is at its maximum in the direction opposite to the reflector.

2. Now, visualize what happens to the pattern when the reflector is rotated about the radiating element of the antenna. The effect is a cardioid pattern, similar to the one shown in figure 1-2B, which rotates about the axis of the antenna at the same rate as the reflector. Figure 1-2C shows five of the positions taken by the antenna pattern during the 360° rotation of the reflector. In the case of pattern number 1, an aircraft located at a position due south of the beacon antenna would receive a half-amplitude signal. If the antenna were rotated through 90° (pattern number 2), the same aircraft would receive a signal at maximum amplitude. Rotating the antenna another 90° (pattern number 3) would cause the aircraft to receive a half-amplitude signal of diminishing strength. Still another 90° rotation of the antenna (pattern number 4) would cause the aircraft to receive a minimum amplitude signal.

Finally, completion of the 360° rotation of the antenna reflector (pattern number 5) would return the signal received by the aircraft to half-amplitude (increasing in strength).

3. The relative amplitudes of the signals received by the aircraft for one complete revolution of the antenna reflector are shown for comparison purposes in figure 1-2D. Although the total beacon output is of constant amplitude through the full 360° rotation of the reflector, the signal received by an aircraft at any given point around the beacon will vary in amplitude, as explained above.

4. The amplitude variation of the envelope of the received pulses follows a sine-wave (approximate) pattern (figure 1-2E), the frequency of which corresponds to the rate of rotation of the reflector around the antenna. Since the reflector rotates about the beacon antenna at a 15-cps rate, an aircraft at any given point in space within range of the beacon will detect the complete sine-wave 15 times per second. See figure 1-2E.

(b) NORTH REFERENCE (15-CPS) BURST.

1. To orient the beacon's bearing information with respect to magnetic north, a group of coded pulses is introduced into the 15-cps amplitude-modulated field of energy radiated by the radio beacon antenna. This group of pulses (or coded burst) is generated once during each revolution of the reflector, and occurs every time the peak of the radiation lobe points due east (with the respect to magnetic north). At that moment a trigger pulse is generated by the antenna that initiates the formation of the burst. The trigger pulse is generated in the following manner: An aluminum disc having a thin iron slug pressed into its edge is attached to the rotating shaft of the antenna. A magnetic pick-up coil located in the north position is mounted so that when the iron slug passes through it once each revolution, the reluctance of the magnetic circuit will be reduced, thereby causing generation of a trigger pulse. See figure 1-3.

2. Figure 1-3 shows the position of the north reference burst on the 15-cps amplitude-modulated sine wave, as seen by four aircraft at four different points around the radio beacon. Figure 1-3A shows the position of the north reference burst on the 15-cps modulation as observed by an aircraft due south of the beacon, flying on bearing 000. This burst appears to occur at the half-amplitude (going position), or 0° point of the sine-wave

modulation. Figure 1-3B shows the north reference burst as observed by an aircraft due west of the beacon, flying on bearing 90°. This burst occurs at the minimum-amplitude 90° point of the sine wave. Figure 1-3C shows the position of the burst for an aircraft due north of the beacon, flying on bearing 180°. Here the burst occurs at the half-amplitude (going negative), or 180° point in the sine wave. Figure 1-3D shows the burst at the maximum-amplitude point of the 15-cps "modulation" (sine wave), as it would be observed by an aircraft to the east of the beacon, flying on bearing 270°. This illustrates how the phase of the 15-cps modulation shifts with respect to the 15-cps north reference burst, as the aircraft moves on a 360° circle around the radio beacon.

3. This phase difference is detected by the aircraft receiver of Radio Set AN/URN-21 and converted to a meter reading in degrees showing the direction of the beacon with respect to the aircraft, referenced to magnetic north.

4. Figure 1-4 illustrates the signals received by four aircraft located at four different points around the radio beacon, and the corresponding meter readings (indicating their bearings when headed toward the beacon). Note that all aircraft receive the north reference burst at the same instant of time, but at different phases of the 15-cps amplitude modulation.

(c) 135-CPS AMPLITUDE MODULATION. - A 135-cps amplitude-modulation component is also imposed on the r-f energy radiated by the radio beacon antenna.

1. The 135-cps modulation is produced, in a manner similar to that described above, by directors which are spaced 40° apart around the radiating element, and which rotate about it at a 15-cps rate.

2. This 135-cps component, acting alone, would shape the antenna pattern as shown in pattern 2 of figure 1-5. The resultant antenna pattern, caused by the combined effect of the 15-cps reflector and the 135-cps directors, is also shown in patterns 3 and 4 of figure 1-5. Note that 135 cps is the ninth harmonic of 15 cps.

(d) AUXILIARY REFERENCE (135-CPS) BURST. - Iron slugs passing through a magnetic pick-up coil initiate the formation of the 135-cps reference bursts, as in the case of the 15-cps reference bursts, but at 40° instead of 360° intervals.

The 135-cps amplitude-modulated component and the 135-cps reference burst are used in a manner similar to that described above for the 15-cps signals.

(2) COMBINING 15-CPS AND 135-CPS COMPONENTS TO PROVIDE BEARING INFORMATION. - Figure 1-6 summarizes the steps involved in the development of the composite 15-cps and 135-cps signal elements into the total bearing information supplied by the radio beacon to the aircraft. The signals, including the 15-cps and 135-cps amplitude modulation and the 15-cps and 135-cps reference bursts, received by the aircraft in positions due east, south, west and north, relative to the beacon, appear as shown. Again, the phase of the modulation relative to the bursts depends on the position of the aircraft relative to the beacon. The 135-cps bursts have simply refined the measurement of angle relative to magnetic north.

c. RADIO BEACON IDENTIFICATIONS. - The radio beacon periodically transmits its identifying call in International Morse Code, thus enabling the aircraft to determine which radio beacon it is in contact with. The characters of the code consist of a train of 1,350 double pulses per second, keyed by a coding wheel built into the radio beacon. The aircraft receiver of Radio Set AN/ARN-21 decodes the pulses representing the identification call, and reproduces them as 1,350-cps identification call signals.

d. DISTANCE MEASURING INFORMATION. - Of all the signals transmitted by the radio beacon, distance measuring information alone is not originated within the beacon. Distance reply signals are supplied by the radio beacon only in response to interrogations from an airborne Radio Set AN/ARN-21. Thus, such information is actually originated by the airborne portion of the Tacan system. Each AN/ARN-21 sends out a sequence of paired pulses at the frequency of the radio beacon receiver, but with a random pulse spacing peculiar to itself. This signal is received by the radio beacon receiver, which is capable of accepting interrogations from up to 100 interrogating aircraft simultaneously. The beacon adds a 50-microsecond delay to the received distance measuring interrogations, and retransmits them to the aircraft as replies at the transmitting frequency of the radio beacon and the coded pulse spacing of the aircraft. The aircraft radio receiver performs the following functions:

(1) Selects the particular distance measuring reply from all other signals by comparing the repetition rate of the reply pulses with the repetition rate of the originally transmitted interrogation pulses, and locking in on the particular reply pulses when their repetition rate is found to be the same as the rate of interrogation pulses.

(2) Subtracts the 50-microsecond zero distance delay time from the total time between transmission and reception of interrogation pulses and converts the remaining round trip travel time of the signal into distance between the aircraft and the beacon. A continuous display indicator on Radio Set AN/ARN-21 displays this diatance in nautical miles.

e. INFORMATION ELEMENT PRIORITY IN THE RADIO BEACON. - The three elements of information (that is, bearing identification call, and distance measuring information), discussed in the preceding subparagraphs, are transmitted by the radio beacon as a train of pulse-pairs. To prevent interference between the three signal elements, the radio beacon is arranged to assign a sequency or priority in which each enters into the overall pulse train.

(1) First in the order of priority are the bearing reference bursts. This is so because the bursts occur at a fixed rate and are of relatively short duration. Accordingly, reference bursts can break in any other information element being transmitted by the beacon.

(2) Second in the order of priority is the identity call signal. The identity call signal also occurs at a fixed rate. However, it is of sufficiently long duration so that the utilization of the portion required for the insertion of bearing reference bursts does not materially affect the reception of intelligible identity code by the aircraft.

(3) Third in the order of priority are the distance interrogation signals. The interrogation pulses are not initiated within the beacon and their arrival within the pulse train must, therefore, be controlled, to prevent their interfering with the other signal elements of the radio beacon. This is done by allowing them to enter the pulse train only during a time interval not occupied by the reference bursts or identity call signals. This is possible because the time occupied by the reference bursts is small in comparison with the time allowed for the total radio beacon signal cycle. In addition, a memory circuit built into the aircraft receiver of Radio Set

AN/ARN-21 makes it possible to compensate for the time interval during which identity tone is transmitted and no reply pulses are received because of the priority system within the beacon.

(4) Last in the order of priority are squitter pulses which are used as fill-in signals when the maximum number of aircraft are not interrogating the beacon. This is necessary to maintain the modulation pattern and to permit constant duty cycle operation of the radio beacon.

(5) The relative duration of the signal elements is such that effectively there is no interruption of bearing, identification call or distance information received by the aircraft.

f. RADIO BEACON DUTY CYCLE.

(1) The term duty cycle is expressed here as percentage of actual transmitting time.

(2) The useful signal pulse-pair contents, per second of operation of the radio beacon, is variable.

(a) 180 north reference burst pulse-pairs per second (12 pulse-pairs occurring 15 times per second).

(b) 720 auxiliary (135 cps) reference burst pulse-pairs per second (6 pulse-pairs occurring 120 times per second).

(c) Identity tone pulses, totaling 2, 700 pulse-pairs per second when keyed. The actual number of code pulse-pairs present depends, however, on the particular code assigned to the radio beacon.

(d) Distance measuring interrogation pulse-pairs, the number of which depends on the number of aircraft interrogating the radio beacon at any particular time. The maximum, for 100 aircraft interrogating the beacon simultaneously, is 2, 700 pulse-pairs per second.

(3) To sustain the sine-wave modulation envelope of the transmitted r-f energy, it is necessary to maintain the total number of pulse-pairs transmitted during each signal cycle constant. The radio beacon maintains a constant duty cycle by introducing into the signal train noise pulses in a number sufficient to bring the total number of pulse-pairs in the signal pulse-train to 3, 600 pulse-pairs per second. The noise pulses thus introduced into the signal are referred to as squitter. Obviously, since the burst pulse-pairs are constant in number, and the identity code pulse-pairs are also constant in number, the number of squitter pulses in the signal train varies inversely

with the number of aircraft interrogating the radio beacon at any given time. Thus, the number of squitter pulses is maximum when no aircraft is interrogating the beacon, and is minimum when the maximum number of 100 aircraft are interrogating the radio beacon at any one time. When the number of aircraft interrogating the beacon exceeds 100 (that is, when the toal number of distance measuring interrogation pulse-pairs exceeds the 2, 700 for which time is available), the excess number of pulse-pairs is gated out.

g. CHARACTERISTIC OF RADIO BEACON SIGNALS.

(1) All signals transmitted by the radio beacon are characterized by the fact that they consist of pulse-pairs, with 12-microsecond spacing between the two pulses of the pair. The number of pulse-pairs per second and the spacings between pulse-pairs (i.e., the spacing between the leading edge of the first pulse of one pair and the leading edge of the first pulse of the next pair) depends upon the particular signal element and is a characteristic of that particular signal element. However, it is the spacing of 12 microseconds between the pulses of a pair which provides the aircraft Radio Set AN/ARN-21 with the means for distinguishing between the signal pulses from the radio beacon and any other pulses which may be present on the received radio frequency.

(2) The characteristics of the signal elements as transmitted by the radio beacon are given below.

(a) NORTH REFERENCE BURST. - Consists of 12 pulse-pairs, with 12-microsecond spacing between pulses of a pair, and a 30-microsecond spacing between pulse-pairs, occurring 15 times per second.

(b) AUXILIARY REFERENCE BURST. - Consists of six pulse-pairs with 12-microsecond spacing between pulses of a pair, and 24 microseconds between pulse-pairs, occurring 120 times per second at the rate of 135 cps.

(c) IDENTIFICATION CODE. - Consists of a train of 2, 700 pulse-pairs per second with 12-microsecond spacing between pulses of a pair occurring at 1, 350-cps double-pulsed rate, keyed by a coding wheel built into the beacon. The tone pulses are synchronized to the reference bursts.

(d) DISTANCE MEASURING INTERROGATIONS. - Consists of pulse-pairs with 12-microsecond spacing between pulses of the pair, the spacing between pulse-pairs depending on the pulse-repetition rate peculiar to the interrogating aircraft.

(e) SQUITTER PULSES. - Consists of pulse-pairs, with 12-microsecond spacing between pulses of the pair, the number of pulse-pairs per second depending on the number of interrogations being received by the beacon, but with a minimum spacing of 40 microseconds between pulse-pairs.

h. HIGH-BAND AND LOW-BAND RADIO BEACON FREQUENCY ALLOCATION.

(1) The radio beacon operates in the frequency range between 962 megacycles and 1,213 megacycles. This frequency range is divided into two transmitting bands and one receiving band as follows:

(a) The band between 962 and 1,024 megacycles is used for transmission from the radio beacon (low band).

(b) The band between 1,025 and 1,150 megacycles is used for reception by the radio beacon (low and high band).

(c) The band between 1,151 and 1,213 megacycles is also used for transmission from the radio beacon (high band).

(2) In any one radio beacon the receiver and transmitter operate at frequencies 63 megacycles apart. Thus, for example, a beacon transmitting at 962 megacycles receives at 1,025 megacycles. Similarly a beacon transmitting at 1,024 megacycles receives at 1,087 megacycles. Also, a transmitter operating at 1,151 megacycles receives at 1,088 megacycles. Finally a transmitter operating at 1,213 megacycles receives at 1,150 megacycles. The frequencies mentioned above serve to illustrate how the end frequencies for each band are used and show how the total frequency range of the radio beacon is divided into low band and high hand. Thus:

(a) A beacon operating in the low band transmits at a frequency between 962 and 1,024 megacycles and receives at a frequency 63 megacycles above the transmitter frequency. This receiver frequency falls in the band of 1,025 and 1,087 megacycles.

(b) Similarly, a beacon transmitting in the high band between 1,151 and 1,213 megacycles receives at a frequency 63 megacycles below the transmitter frequency. In this case the receiver frequency falls in the bank between 1,088 and 1,150 megacycles.

(3) Beacons are provided to operate either in the high band or in the low band, depending on the antenna used. Except for the fact that the high-band and the low-band antennas differ in size, they are identical in every respect.

3. DESCRIPTION OF RADIO BEACON EQUIPMENTS.

The radio beacon equipments are supplied and arranged for either shipboard or shore installations, and for either low (5 kw) or high (7.5 kw, min.) transmitter outputs. The basic components are very similar; the differences are in the antenna groups used, in the power output stages of the transmitters, and in the arrangement of the primary power input circuits to correspond to the types of primary power available to shipboard and shore installations. The major components of the three types of radio beacons described in this instruction book are listed in the following subparagraphs.

a. SHORE RADIO BEACON USING RADIO SET AN/GRN-9 WITH TYPE SAL-39A KLYSTRON. (See figure 1-1, items a and b.) - This radio beacon employs the following major components:

(1) Receiver-Transmitter Group OA-1533/GRN-9 (figure 1-7), including:

(a) Radio Receiver R-824/URN

(b) Coder-Indicator KY-235/URN

(c) Amplifier-Modulator AM-1702/GRN-9.

(d) Frequency Multiplier-Oscillator CV-590/GRN-9

(e) Control-Duplexer C-2226/GRN-9

(f) Electrical Equipment Cabinet CY-2185/GRN-9

(2) Power Supply Assembly OA-1536/GRN-9 (figure 1-8) including:

(a) Low Voltage Power Supply PP-1766/URN

(b) Medium Voltage Power Supply PP-1765/URN

(c) High Voltage Power Supply PP-1764/URN

(d) Electrical Equipment Cabinet CY-2188/GRN-9

Note

Space is provided in the power supply assembly for the test equipment listed in (a) to (d) below. Switch-Test Adapter SA-420/URN-3 is mounted external to the radio set. The test equipment, referred to as built-in test equipment, is to be installed by the using activity after delivery of the power supply assembly from the manufacturer.

(a) Pulse-Analyzer-Signal Generator TS-890/URN-3 (see Technical Manual NAVSHIPS 92819)

(b) Pulse Sweep Generator SG-121/URN-3 (see Technical Manual NAVSHIPS 92745)

(c) Oscilloscope OS-54/URN-3 (see Technical Manual NAVSHIPS 92778)

(d) Power Meter-Pulse Counter TS-891/URN-3 (see Technical Manual NAVSHIPS 92809)

(e) Switch-Test Adapter SA-420/URN-3 (see Technical Manual NAVSHIPS 92809)

(3) Shore antenna group (not supplied)

b. SHORE RADIO BEACON USING RADIO SET AN/GRN-9A WITH SAL-89 KLYSTRON. (See figure 1-1, items a, b, c and d.)- This radio beacon employs the following major components:

(1) Receiver-Transmitter Group OA-1534/GRN-9A (figure 1-7) including the following drawer units within the cabinet:

(a) Radio Receiver R-824/URN

(b) Coder-Indicator KY-235/URN

(c) Amplifier-Modulator AM-1701/URN

(d) Frequency Multiplier-Oscillator CV-589/URN

(e) Control-Duplexer C-2226/GRN

(f) Electrical Equipment Cabinet CY-2186/GRN-9A

(2) Power Supply Assembly OA-1537/GRN-9A (figure 1-8) including the following drawer units within the cabinet:

(a) Low Voltage Power Supply PP-1766/URN

(b) Medium Voltage Power Supply PP-1765/URN

(c) High Voltage Power Supply PP-1763/URN

(d) Electrical Equipment Cabinet CY-2189/GRN-9A

Note

Space is provided in the power supply assembly for the test equipment listed in (a) to (d) below. Switch-Test Adapter SA-420/URN-3 is mounted external to the radio set. This test equipment, referred to as built-in test equipment, is to be installed by the using activity after delivery of the power supply assembly from the manufacturer.

(a) Pulse Analyzer-Signal Generator TS-890/URN-3 (see Technical Manual NAVSHIPS 92819)

(b) Pulse Sweep Generator SG-121/URN-3 (see Technical Manual NAVSHIPS 92745)

(c) Oscilloscope OS-54/URN-3 (see Technical Manual NAVSHIPS 92778)

(d) Power Meter-Pulse Counter TS-891/URN-3 (see Technical Manual NAVSHIPS 92809)

(e) Switch-Test Adapter SA-420/URN-3 (see Technical Manual NAVSHIPS 92809).

(3) Shore Antenna Group OA-1547/URN (low band; figure 1-9) or OA-1548(high band) including the following:

(a) Antenna AS-891/URN (low band) or Antenna AS-892/URN (high band)

(b) Antenna Pedestal AB-541/URN

(c) Electronic Control Amplifier AM-1720/URN (shore speed control unit) (figure 1-10).

c. SHIPBOARD RADIO BEACON USING RADIO SET AN/SRN-6 WITH TYPE SAL-89 KLYSTRON. (See figure 1-1, items a, b, e, f and g.)- This radio beacon employs the following major components:

(1) Receiver-Transmitter Group OA-1532/SRN-6 (figure 1-7), including the following drawer units within the cabinet:

(a) Radio Receiver R-824/URN

(b) Coder-Indicator KY-235/URN

(c) Amplifier-Modulator AM-1701/URN

(d) Frequency Multiplier-Oscillator CV-589/URN

(e) Control-Duplexer C-2225/SRN-6

(f) Electrical Equipment Cabinet CY-2184/SRN-6

(2) Power Supply Assembly OA-1535/SRN-6 (figure 1-8), including the following drawer units within the cabinet:

(a) Low Voltage Power Supply PP-1766/URN

(b) Medium Voltage Power Supply PP-1765/URN

(c) High Voltage Power Supply PP-1763/URN

(d) Electrical Equipment Cabinet CY-2187/SRN-6

Note

Space is provided in the power supply assembly for the test equipment listed in (a) to)d) below. Switch-Test Adapter SA-420/URN-3 is mounted external to the radio set. This test equipment, referred to as built-in test equipment, is to be installed by the using activity after delivery of the power supply assembly from the manufacturer.

(a) Pulse Analyzer-Signal Generator TS-890/URN-3 (see Technical Manual NAVSHIPS 92819)

(b) Pulse Sweep Generator SC-121/URN-3 (see Technical Manual NAVSHIPS 92745)

(c) Oscilloscope OS-54/URN-3 (see Technical Manual NAVSHIPS 92778)

(d) Power Meter-Pulse Counter TS-891/URN-3 (see Technical Manual NAVSHIPS 92809)

(e) Switch-Test Adapter SA-420/URN-3 (see Technical Manual NAVSHIPS 92809)

(3) Power Distribution Transformer TF-235/URN-3.

(4) Shipboard Antenna Group OA-1545/SRN-6 (low band) or OA-1546/SRN-6 (high band) (figures 1-11, 1-12, 1-13), including the following:

(a) Antenna AS-889/SRN-6 (low band) or AS-890/SRN-6 (high band)

(b) Antenna Pedestal AB-540/SRN-6

(c) Electronic Control Amplifier AM-1718/SRN-6 (shipboard speed control unit)

(d) Electronic Control Amplifier AM-1719/SRN-6 (shipboard roll, pitch and azimuth control unit or "deck box")

(e) Radome CW-441/SRN-6

d. BASIC DIFFERENCES BETWEEN SHORE AND SHIPBOARD EQUIPMENTS.

(1) ANTENNA GROUPS. - For the proper operation of the radio beacon, it is necessary that the antenna be maintained in a position perpendicular to the earth's surface, so that the antenna radiation pattern maintains a constant relationship to the azimuth plane. In addition, it is necessary that the antenna radiation pattern be constantly referenced to magnetic north. A ship in motion violates both of the above conditions, since not only does the ship change its own bearing relative to magnetic north but also is subject to roll and pitch. Accordingly, the antenna equipment provided for shipboard use is fitted with control facilities and circuits for compensating for these variable factors. These facilities and circuits include:

(a) roll compensation servo circuits;

(b) pitch compensation servo circuits;

(c) magnetic variation compensation circuits.

In the case of land-based installations, such variable factors do not as a rule play a part, and are, accordingly, not provided for. A magnetic variation assembly is included in the antenna equipment for shore use. In this case, however, this unit is set manually during initial installation, and is not used thereafter. In the case of shipboard antenna equipment the beaming signals furnished by ship's gyro compass in conjunction with the correcting factor set in by the magnetic variation assembly serve to maintain the antenna radiation pattern referenced to magnetic north, with changes in ship's heading. The correcting factor set in manually by means of the magnetic variation assembly depends on the geographical location of the ship and is determined from geodetic survey maps.

(2) PRIMARY POWER DISTRIBUTION. - Shore-based equipment is arranged to operate from a primary power source of 208 volts, three-phase, four-wire, 55-65 cps. It also utilizes 120 volts obtained by connection between one phase and neutral. Shipboard equipment is arranged to operate from a primary power source of 440 volts, three-phase, three-wire, 55-65 cps, and a separate primary power source of 117 volts, single-phase, 55 to 65 cps. The primary power distribution circuits for shipboard and shore equipments, as well as for the receiver-transmitter groups, the power supply assemblies and the antenna control equipments are arranged accordingly.

4. ARRANGEMENT OF RECEIVER-TRANSMITTER AND POWER SUPPLY ASSEMBLY COMMON FEATURES.

a. The component units of the receiver-transmitter group (figure 1-7) and power supply assembly (figure 1-8) are mounted in rack frames, which in turn are mounted in cabinets. Component units containing the actual transmitting, receiving, coding, timing, test, and power supply circuits are arranged into panel-and-chassis-type drawer units to facilitate servicing. Other components of these groups, such as filament supply and blower units, are fixed-type panel-and-chassis assemblies.

The component units of the two groups are distributed so that, as a rule, each cabinet contains units with similar or related functions.

b. The drawer-type panel-and-chassis assemblies are arranged to slide in and out of the cabinet on slide rails mounted on the rack frame. A typical arrangement is shown in figure 1-14. When fully inserted in the frame, the drawers are secured to the frame by means of captive screws. To open a

drawer, it is merely necessary to release the captive screws and to pull on the panel-mounted handles. Latches provided on the sides of the drawer units lock the drawer in place when partly extended for inspection, adjustment or servicing. Interunit cabling connections to the drawer units are made either by means of plug-in screw-type multiconnectors, or by means of leads fitted with terminal lugs arranged for connection to screw-type terminal boards. No solder connections exist in the interunit cabling. The interunit cabling attached to the drawer units is retractile and is long enough to permit the unit to be fully extended for inspection, servicing, and adjustments. Opening the latches and disconnecting the interunit cabling permits the drawer unit to be completely removed from the rack frame.

c. In general, the power supply and power distribution circuits and some of the power circuit controls are located in the power supply assembly. However, the coder-indicator and the radio receiver, both located in the receiver-transmitter group, have their own built-in power supplies. Power to the individual drawer and fixed-mounted units is brought through interlocks mounted behind the front panels on the rack-frame. The interlocks are so arranged that opening the particular drawer unit will disable power not only to that particular unit but to the other units functionally related to it. Thus, disabling one of the drawers forming part of the overall transmitter disables all units of the transmitter. To permit the drawer units to be serviced when open, facilities are provided to either bypass the interlocks or to reset the individual interlock. Exceptions to this are the amplifier-modulator and the high-voltage power supply drawer units. In these cases, because of the very high voltages exposed when either drawer is open, no facilities are provided for "cheating" the high-voltage interlock.

d. The receiver-transmitter group and power supply assembly each have their own ventilating system, including ventilating ducts and blower motors. In addition, some individual drawer units have their own cooling systems, as required. Since continued operation of the cooling system is very important to the proper operation of the equipment, facilities are provided for:

(1) providing visual indication of cooling system failure (AIR SWITCH OPEN lamps), and

(2) automatic shutdown of the system in the event of cooling system failure.

e. In general, operating controls, indicating lamps, meters, test jacks,

and fuses are on the front panels of the component units. Adjustment controls, circuit breakers, and other controls associated with dangerous potentials, or controls the accidental misadjustment of which can cause damage to the equipment, are located behind hinged doors on the front panels. Tuning adjustments are located on the individual chassis.

f. Intergroup cabling is brought into the receiver-transmitter group and the power supply assembly cabinets through cable entrance boxes mounted on the rear of the cabinets, and fitted with removable access covers.

5. DESCRIPTION OF RADIO RECEIVER R-824/URN. (See figure 1-15.)

a. FUNCTIONS. - The radio receiver performs the following functions:

(1) It receives from the control-duplexer the interrogation pulse-pairs transmitted by the aircraft.

(2) Converts the received distance interrogation pulse-pairs, along with random noise pulses generated within the receiver mixer and first preamplifier stages into an intermediate frequency of 63 megacycles, and amplifies and demodulates these signals.

(3) Produces, by means of a coincidence type decoding circuit, a single pulse for each pulse-pair (interrogation or noise), the pulses of which are separated by 12 microseconds and of sufficient amplitude to pass through the coincidence decoder.

(4) Assures, by means of a blanking circuit, a separation of 40 microseconds between decoded pulses, by blanking out any pulse which occurs less than 40 microseconds after the preceding pulse.

(5) Maintains an output constant at 2, 700 ±90 pulses per second, reardless of the interrogation rate.

b. PANEL-MOUNTED FACILITIES. - The front panel of the unit mounts a 100-milliampere, full-scale, d-c milliammeter, and a multiposition METER SELECTOR switch. The switch connects the meter to various circuits for checking various voltages, as indicated by the switch positions. Also mounted on the front panel are a TEST OUTPUT jack, a POWER ON switch that applies power to the receiver power supply, a POWER ON lamp that lights to indicate the presence of required voltages, two fuses and a spare fuse. The cap of each fuseholder contains a lamp that lights when the fuse is blown.

c. SUBASSEMBLIES. - The radio receiver contains four subassemblies. These are: a mixer and preamplifier subassembly, an i-f amplifier subassembly, video amplifier subassembly, and a power supply subassembly. The function of each subassembly is given below.

(1) MIXER AND PREAMPLIFIER. - The mixer and preamplifier consist of a balanced hybrid T-type mixer and a three-stage preamplifier. The local oscillator signal is fed into one arm of the mixer and the interrogation pulse-pairs are fed into the other arm. The resultant intermediate frequency, which is 63 megacycles, is amplified in the three-stage preamplifier.

(2) I-F AMPLIFIER. - The i-f amplifier raises the interrogation pulses and random noise pulses at the intermediate frequency appearing at the output of the preamplifier to a level sufficient to operate the Ferris discriminator. The discriminator functions to detect the interrogation and random noise pulses and to provide adjacent and near-adjacent channel rejection. The output of the discriminator, a video signal, is further amplified in the i-f amplifier subassembly before it is fed to the receiver video amplifier subchassis. Also employed in the i-f amplifier are echo-suppression circuits that permit operation in areas where large reflecting objects are present. A squitter-control voltage, generated in the video amplifier subassembly, is fed into the i-f amplifier for the purpose of maintaining the receiver output constant at 2, 700 ±90 pulses per second. The squitter-control voltage is thus a form of AGC.

(3) VIDEO AMPLIFIER. - The video amplifier receives the i-f amplifier output, noise and interrogation pulses, and further amplifies these video signals to a level which can operate the coincidence-type decoder. The decoder functions to produce at its output a single pulse for each input pulse-pair having pulses separated by 12 microseconds. The decoding of each pulse-pair is followed by a 40-microsecond blanking of the receiver to insure a relatively uniform envelope of the total radio beacon output pulse train. In addition, a pulse-counter circuit produces the squitter-control voltage (referred to above), which is fed back to the i-f amplifier. This voltage controls the gain of the i-f amplifier circuit so that 12-microsecond separated pulse-pairs (interrogations) and decoded random noise groups effect the desired output of 2, 700 pulses per second. When the rate of interrogation pulse-pairs falls below 2, 700 pulse-pairs per second, a sufficient number of random noise

pulse-pairs, the pulses of which are also 12 microseconds apart, are decoded to maintain receiver output at the required rate. Under normal conditions the maximum interrogation rate should not be above 2,500 pulses per second.

(4) RECEIVER POWER SUPPLY. - The receiver power supply furnishes filament voltage and a regulated 150-volt B+ supply voltage for the receiver, and a regulated -105-volt negative bias supply.

6. DESCRIPTION OF CODER-INDICATOR KY-235/URN.
(See figure 1-16.)

a. FUNCTIONS. - The coder-indicator performs the following functions:

(1) Generates a 15-cps reference burst each time a 15-cps trigger video pulse is generated in the antenna (see paragraph 5c (2)).

(2) Generates a 135-cps reference burst each time a 135-cps trigger video pulse is generated in the antenna (see paragraph 5c (2)).

(3) Generates a radio beacon identification call of 1,350 cps in International Morse Code keying for transmission at specific intervals.

(4) Processes the distance interrogation pulses appearing at the receiver output, and, in combination with time delays in the receiver and transmitter, adjusts their net transit time through the beacon to exactly 50 microseconds.

(5) Assigns priorities of transmission to the components of the signal, which consists of the bearing reference bursts, the radio beacon identification call, and the replies to distance interrogations and random noise pulses (see paragraph 5c (2)).

(6) Combines the various components of the signal.

(7) Encodes the transmission signals to give them the characteristics identifying them as the radio beacon signals (see paragraph 5c (2)).

(8) Provides an accurate 1,350-cps signal to be used in checking the accuracy of the speed of rotation of the antenna parasitic elements.

(9) Provides a means for adjustment to compensate for variations between magnetic north and true north.

b. PANEL-MOUNTED FACILITIES. - The front panel of the coder-indicator mounts the ANTENNA SERVOS meter and METER SELECTOR switch, which provide a means of checking the error voltages developed in the antenna control circuits to maintain correct azimuth, speed of rotation, pitch, and roll. Also mounted on the front panel are the ANTENNA POSITION SELECTOR switch, CODER INDICATOR OFF-ON switch, ANTENNA CONTROL and POWER ON

lamps, SYNC OUT and TEST OUTPUT jacks, two three-ampere fuses and one spare fuse, and the SET TO MAGNETIC VARIATION dial, which permits correction in azimuth for variations between true north and magnetic north.

c. SUBASSEMBLIES OF CODER-INDICATOR KY-235/URN.

(1) VIDEO CHASSIS. - The video chassis subassembly includes the electrical circuits necessary to perform the functions listed in paragraph 6a (1) through (8) above.

(2) POWER SUPPLY SUBASSEMBLY. - The power supply provides the d-c and filament voltages for all the circuits of the coder-indicator. A power ON-OFF switch located on the front panel of the coder-indicator applies power to this power supply.

(3) KEYER SUBASSEMBLY. - The keyer subassembly provides the timing and keying to the 1,350-cps identification tone produced in the video chassis so that the beacon will send out the proper identification call signal. The keyer subassembly is located on the right side of the drawer assembly inside the unit.

(4) MAGNETIC VARIATION SUBASSEMBLY. - The magnetic variation subassembly control knob on the front panel provides a means of adjustment to compensate for variations between magnetic north and true north. The subassembly is mounted on the back of the front panel.

(5) THE DELAY LINE SUBASSEMBLY. - The delay line subassembly, which is mounted on the video chassis, consists of a distributed constant delay line, capable of a maximum delay of 48 microseconds. Included are controls which permit continuous adjustment of delay from 40 to 48 microseconds so as to provide an overall "zero-distance" delay through the radio beacon of 50 microseconds.

d. COMPONENTS OF ANTENNA SERVO SYSTEM LOCATED IN CODER-INDICATOR. - The coder-indicator includes several components of the antenna servo systems. These include differential generator switching and indicating components.

(1) The magnetic variation subassembly allows the operator to insert manually into the bearing servo system the variation between true north of the ship's compass repeater system and magnetic north so that bearings are referred to magnetic north. The magnetic variation subassembly may also be used for ease of installation of mobile shore radio beacons, making it possible

to align the radio beacon with magnetic north without aligning the mobile unit (truck, trailer, etc.) with magnetic north.

(2) The antenna switch labeled ANTENNA POSITION SELECTOR enables the operator to lock the antenna in a position perpendicular to the deck by means of the stabilization servo system. This may be desirable when the antenna is not in use.

(3) The ANTENNA SERVOS meter and its associated five-position METER SELECTOR switch is used in shipboard operation, to indicate functioning of the antenna stabilization system in roll, pitch, and bearing. For both shipboard and shore installations, it indicates correct or incorrect antenna rotation speed.

(4) An amber warning lamp marked ANTENNA CONTROL is illuminated steadily during normal operation, but blinks to indicate a blown fuse or the loss of a critical voltage in the antenna control unit.

Note

In the following descriptions of the frequency multiplier-oscillator and amplifier-modulator, all references to Radio Set AN/GRN-9A also apply to Radio Set AN/SRN-6.

7. DESCRIPTION OF THE FREQUENCY MULTIPLIER-OSCILLATOR.

(See figure 1-17.)

a. FUNCTIONS.

(1) Generates the fundamental frequency by means of its crystal oscillator and multiplies this frequency to the channel frequencies.

(2) Provides the radio receiver with local oscillator signal.

(3) Provides r-f drive power to the klystron.

(4) Generates the klystron gate pulse.

b. PANEL-MOUNTED FACILITIES. - Monitoring is accomplished by means of a selector switch mounted at the left-hand side of the front panel and a microammeter mounted on the front panel above the selector switch and marked TUNING. Another selector switch and a kilovoltmeter labeled DC SUPPLY VOLTAGE, both mounted at the right-hand side of the front panel, are used to check the various voltage inputs to the unit.

Test jacks for monitoring and tuning the unit and lamps, which, when illuminated, indicate that filament voltage and crystal oven heaters are operating, are also mounted on the front panel.

c. SUBASSEMBLIES OF FREQUENCY MULTIPLIER-OSCILLATOR. - The frequency multiplier-oscillator contains two exciter r-f chassis (high and low band) and a video chassis.

(1) EXCITER R-F CHASSIS. (See figure 1-18.)- Two complete crystal oscillator and frequency multiplier chains are provided. One is used for low-band operation of the radio beacon and the other for high-band operation. The following applies to both: The exciter r-f chassis generates the initial frequency, a signal in the range of from 40 to 51 megacycles. This frequency is multiplied by three doubler stages and one tripler stage to achieve a total frequency multiplication of 24. The signal is then fed to a pair of r-f amplifiers where, in Radio Set AN/GRN-9, it is keyed and modulated by a shaped 3.5-microsecond pulse from the video chassis, and in Radio Set AN/GRN-9A it is keyed by a 10-microsecond pulse from the video chassis. This signal is used as the klystron r-f drive power. In addition a portion of the signal is tapped off the tripler stage and is used as the radio receiver local oscillator signal.

(2) VIDEO CHASSIS. - The output of the coder-indicator is fed to two pulse-forming networks in the video chassis of the frequency multiplier-oscillator. One network receives 1.5-microsecond rectangular pulses from the coder-indicator and converts them to shaped 3.5-microsecond pulses. In Radio Set AN/GRN-9 the shaped pulses are used to key and plate-modulate the final two r-f amplifiers in the r-f chassis mentioned in the previous paragraph. In Radio Set AN/GRN-9A the shaped pulse is used to grid-modulate the klystron beam current.

The same pulses that initiate the formation of the 3.5-microsecond shaped pulses are used to trigger the second network, a 10-microsecond pulse-forming network.

In Radio Set AN/GRN-9 the 10-microsecond pulses are amplified in the amplifier-modulator and used as the klystron keying pulse. In Radio Set AN/GRN-9A the 10-microsecond pulses are used to key the r-f amplifiers as described previously under paragraph 7c (1) above.

8. DESCRIPTION OF THE AMPLIFIER-MODULATOR.

a. FUNCTION. - The principal function of the amplifier-modulator is to develop high-powered pulses of r-f energy which occupy a limited amount of r-f spectrum about the carrier frequency, and which occur at the repetition rate set by the overall pulse train at the output of the coder-indicator.

b. COMMON PANEL-MOUNTED FACILITIES. - Mounted on the front panel of the unit are three fuses that protect the filament circuits and three spare fuses. The caps of the fuseholders include lamps that are lighted when a fuse blows. An indicating lamp, DS1303, marked AIR SW OPEN, is illuminated when the klystron is not receiving sufficient cooling air. At the top center of the front panel are a CHARGING CURRENT milliammeter, M1301, and a H. V. SUPPLY kilovoltmeter, M1302. Illumination of the FIL lamp indicates presence of filament voltages. A hinged door is provided on the panel to provide access to the klystron compartment, for installation and adjustment.

c. AMPLIFIER-MODULATOR AM-1702/GRN-9. (See figure 1-14.) - Amplifier-Modulator AM-1702/GRN-9, used in Radio Set AN/GRN-9, contains a low-level modulator and a high-level modulator. The front panel includes a BEAM PULSE test jack, which provides a means of checking the klystron beam pulse, and a red +700 V Lamp that indicates the presence of +700 volts on the screen of V1302, when on.

(1) LOW-LEVEL MODULATOR. - The function of the low-level modulator is to amplify the input 10-microsecond wide beam pulses from the frequency multiplier-oscillator to a level sufficient to drive the high-level modulator stages.

(2) HIGH-LEVEL MODULATOR. - The high-level modulator receives the 10-microsecond beam pulses and applies them as 11,000-volt, 10-microsecond pulses to the cathode of the klystron. Coincident with application of the 10-microsecond beam pulse a 3.5-microsecond r-f shaped pulse is applied to the grid of the klystron. The output of the klystron is the train of shaped 3-5-microsecond pulses at a high-power level. This output is applied to the duplexer and then fed to the antenna.

d. AMPLIFIER-MODULATOR AM-1701/URN. (See figure 1-19) - Amplifier-Modulator AM-1701/URN, used in Radio Set AN/GRN-9A and AN/SRN-6, contains a high-level modulator and a regulated bias supply. The function of each is given below.

(1) HIGH-LEVEL MODULATOR. - The high-level modulator receives the 3.5-μsec shaped pulse from the frequency multiplier-oscillator and applies it to the SAL-89 klystron modulating grid to grid-modulate the klystron beam current. The 10-μsec r-f pulse from the frequency multiplier-oscillator is applied to the klystron input cavity coincident with the

application of the 3.5-μsec shaped pulse on the klystron grid. These pulses, in conjunction with 12 kv applied between klystron cathode and collector plate, result in high-powered r-f pulses having an envelope corresponding to the 3.5-μsec shaped pulse at the klystron output.

(2) REGULATED BIAS SUPPLY. - The regulated bias supply provides sufficient grid bias to cut off the flow of beam current in the SAL-89 klystron in the absence of keying pulses on the grid. During the time that the positive 3.5-μsec pulse exceeds the bias voltage applied to the grid of the klystron grid current will flow. The regulated bias supply must provide a low impedance path for this current while maintaining good regulation of bias voltage applied to the klystron grid.

CAUTION

The entire regulated bias supply is insulated from ground and all mechanical and electrical components of the bias supply are 12 kv above ground when power is applied to the amplifier-modulator. Although the a-c power to the amplifier-modulator is cut off, and the d-c high-voltage points are automatically grounded when the amplifier-modulator drawer is opened, safety precautions must be observed when servicing or adjusting this circuit.

9. DESCRIPTION OF THE CONTROL-DUPLEXER.

(See figure 1-20.)

a. FUNCTIONS.

(1) The control-duplexer incorporates the major part of the circuits that control power distribution to the other circuits of the radio beacon.

(2) Included in the control-duplexer drawer is the duplexer assembly. The function of the duplexer is to permit both the receiver portion and the transmitter portion of the radio beacon to be connected to and work over a common antenna. The duplexer routes transmitter frequency from the transmitter out to the antenna, and blocks this signal from entering the radio receiver.

The antenna receives distance interrogation signals from interrogating aircraft. The duplexer routes these signals to the radio receiver and prevents them from entering the transmitter portion of the radio beacon.

supply is energized. A green lamp, DS1601, located directly below the LV ON lamp, lights to indicate the availability of the -375-volt supply. Fuses for the rectifier plate and filament transformers are also mounted on the front panel. The caps of the fuseholders contain neon lamps that glow when a fuse is blown. An outlet, J1609, for a sound-powered telephone is also located on the front panel. This permits a closed circuit telephone connection typing together the power supply assembly, receiver-transmitter group and either the shipboard antenna group or the shore antenna group. A power ON-OFF switch provides for energizing or de-energizing the unit.

11. DESCRIPTION OF THE MEDIUM VOLTAGE POWER SUPPLY PP-1765/URN. (See figure 1-22.)

a. FUNCTION. - The medium-voltage power supply delivers regulated d-c power at 1,000 volts to the frequency multiplier-oscillator and +700 volts to the amplifier-modulator. The medium-voltage power supply inputs are 120 volts, single phase, 60 cycles unregulated, and 120 volts, single phase, 60 cycles regulated. The rectifier tube plate transformers are supplied the unregulated input. The filament transformers are supplied the regulated 120-volt input from the filament bus. This input voltage can be adjusted to exactly 120 volts by means of the variac located in the control-duplexer.

The medium-voltage power supply rectifier is of the full-wave type, incorporating two half-wave rectifier tubes. A series regulator is used for the 1,000-volt output. The 700-volt output is obtained by voltage dropping across resistors in the 1,000-volt output. Test jacks are provided for checking the 1,000-volt and +700-volt outputs. The output voltages can be monitored by means of the meter and meter switch on the front panel of the frequency multiplier-oscillator. When used with Radio Sets AN/GRN-9A and AN/SRN-6, the +700-volt output is not connected to the amplifier-modulator.

b. OVERLOAD PROTECTION. - Automatic protection against sustained overloads is provided within the medium-voltage power supply for the units connected to it. To establish whether or not a sustained overload exists, the protection circuit turns the power supply off and on three times in succession before turning it off completely. The same circuit is also wired into the high-voltage power supply circuits. Hence, an overload condition affecting either one of the two power supply units will turn off both.

c. FRONT PANEL FACILITIES.

(1) A blue lamp, DS1605, located on the front panel of the low-voltage power supply, is illuminated when the control circuits located in the control-duplexer make the medium-voltage power supply ready for energizing.

(2) A red lamp, DS1801, marked +700V and +1000V, lights to indicate when these two outputs are present.

(3) Fuses mounted on the front panel protect the plate and filament transformer circuits. The fuses have blown fuse indicating lights, similar to the one in the low-voltage power supply.

(4) A power ON-OFF switch permits energizing or de-energizing the unit.

12. DESCRIPTION OF THE HIGH VOLTAGE POWER SUPPLIES PP-1763/URN AND PP-1764/URN. (See figure 1-23.)

a. FUNCTION. - The high-voltage power supply furnishes 12,000 volts dc, unregulated, to the amplifier-modulator. The input to this power supply, 9,220 volts, three phase, 60 cycles, ac, is obtained from transformer T1001 located in the blower compartment of the power supply assembly cabinet. The rectifier is of the full-wave type employing six tubes operated in series-parallel. A simple capacitor filter is employed. Overload protection is provided by the circuit located in the medium-voltage power supply. A high-voltage shorting switch, S901, which automatically shorts the high-voltage terminals of the filter capacitors when the unit is withdrawn from the cabinet, is provided.

b. FRONT PANEL FACILITIES. - The front panel mounts;

(1) A blue lamp, DS1902, marked HV READY, which lights to indicate that the control circuits have made the high-voltage power supply ready for energizing.

(2) A red lamp, DS1901, marked H. V. ON, lights to indicate the presence of high voltage.

(3) An amber lamp, DS1903, marked HV OVERLOAD, is illuminated when an overload is present and there is trouble in the power supply.

(4) A running time meter, labeled H. V. PLATE HOURS, records the total number of hours that the plate circuit has been energized.

(5) A second running time meter, M1902, marked FILAMENT HOURS, records the number of hours that the filament transformer circuits have been energized.

(6) An HV ON-OFF switch, S1902, permits energizing or de-energizing the unit.

c. DIFFERENCES BETWEEN HIGH VOLTAGE POWER SUPPLIES PP-1763/URN AND PP-1764/URN.

(1) In Power Supply PP-1764/URN, used in Radio Set AN/GRN-9, the output voltage is positive 12 kv with the negative side of the power supply grounded directly to the power supply chassis.

(2) In Power Supply PP-1763, used in Radio Sets AN/GRN-9A and AN/SRN-6, the output voltage is negative 12 kv, with the positive side of the power supply above ground in the power supply chassis. To permit metering of the power supply output current by the BEAM CURRENT meter on the front panel of the amplifier-modulator, the positive side of the power supply output is grounded through the BEAM CURRENT meter to the chassis of the amplifier-modulator.

(3) Output voltage supervisory relay K1904 and delay relay K1905 are included in the control circuits of Power Supply PP-1764/URN only.

13. ANTENNA GROUPS.

a. FUNCTIONS. - The antenna group of the radio beacon performs the following functions:

(1) Receives distance interrogation pulse-pairs from the aircraft.

(2) Radiates the radio beacon output signals which the aircraft receive and process to obtain distance and bearing information.

(3) Provides bearing reference pulses to trigger the coder-indicator at specific intervals.

b. FEATURES COMMON TO SHIP AND SHORE ANTENNA GROUPS. - The following components are common to both shipboard Antenna Group OA-1545/SRN-6 and shore Antenna Groups OA-1547/URN and OA-1548/URN:

(1) ANTENNA. (See figures 1-10 and 1-24.) - The antenna consists of a central antenna array which is its primary radiator. The array is mounted on a stationary shaft and is at the center of two concentric rotating cylinders. Each cylinder contains parasitic reflector wires. The inner cylinder contains reflector wires spaced so as to produce the 15-cps modulation. The outer cylinder contains parasitic elements spaced around the cylinder so as to produce the 135-cps modulation. The two cylinders are held rigidly together, and rotate as a unit at 900 rpm, corresponding to the rotational speed of the

15-cps modulation. The rotating cylinders are protected by a stationary antenna cover called a radome. The shaft upon which the rotating assembly rides is hollow to permit passage of the r-f transmission line which feeds the central array. Cutaway views of the antenna, showing the elements described above, are shown in figures 7-39.28 and 7-39.29.2.

(2) ANTENNA PEDESTAL.

(a) In addition to supporting the antenna, the antenna pedestal (see figure 1-25) houses the induction motor that drives the antenna rotating cylinders by means of a toothed belt. Constant speed of the spin motor (induction motor) is determined by use of a tachometer generator mounted on the spin motor housing and connected in tandem by a common motor shaft. (See figure 7-39.18.3) The tachometer generates a 675-cps voltage when the cylinders are rotating at 900 rpm. Any deviation from this speed of rotation develops a voltage that is used to automatically correct the speed of the spin motor.

(b) A pulser plate assembly (see figure 2-29.1) is rigidly connected to the main shaft that drives the antenna rotating cylinders. On the outer edge are embedded nine soft iron slugs that pass through a pulser coil assembly to generate the 15-cps and 135-cps pulses (refer to Section 2, paragraph 9 a (1)). The above arrangement is known as the reference pulse generator. The pulser coils are mounted on a carriage assembly, the position of which is varied by the north reference servo assembly. The related servo system functions to maintain the reference bursts and r-f modulation in their proper relationship to magnetic north, as described in Section 2, paragraph 9 a (2). The servo assembly, mounted on the pedestal, in the lower housing, varies the position of the pulser coil and carriage assembly by means of its gear train.

(c) Electrical interconnection of the components is facilitated through the use of terminal blocks mounted on the components and on the pedestal housing. A sound-powered telephone outlet is provided to permit communication between the antenn location and the location of the other major equipment groups. An a-c outlet and a main power safety switch, also provided, are mounted on the pedestal frame. The safety switch provides a means of shutting off all power to the antenna, independent of the remotely located control units.

c. SHIPBOARD ANTENNA GROUP.
(See figure 1-24.)

(1) ANTENNA PEDESTAL. - Shipboard and shore antenna pedestals each house the antenna mechanism. In addition to the antenna mechanism which is common to both shipboard and shore antenna groups, the shipboard antenna contains pitch and roll servo motors and associated gear trains which form part of the shipboard stabilized antenna system. The pedestal includes a gimbal, an antenna mounting ring, and components for tilting the antenna as required to compensate for the pitch and roll of the ship. A tachometer generator, geared to the pitch servo motor, and a similar tachometer, geared to the roll servo motor, are used to provide rate feedback, thereby providing a smoother operation of the servo system. Each of the two servo motors is equipped with a blower that is used to provide adequate air circulation to the components.

(2) SHIPBOARD ANTENNA CONTROL AM-1719/SRN-6. - This control unit (see figure 1-12) consists of a bearing (azimuth) amplifier, a pitch amplifier, and a roll amplifier as major subassemblies, and relays, contactors, fuses and miscellaneous controls and switches. The azimuth amplifier supplies the control signal to the bearing servo motor, for proper orientation of the reference bursts. The pitch and roll amplifiers supply the signals that cause the respective servo motors to act to stabilize the antenna by compensating for the pitch and roll of the ship.

(3) SHIPBOARD ANTENNA CONTROL AM-1718/SRN-6. - This control unit (see figure 1-13) consists of the speed control amplifier which acts to regulate the speed of the antenna spin motor. The amplifier consists of a preamplifier and a power amplifier. Shipboard and shore speed control units are identical, except that shipboard power amplifier requires an input of 440 volts, three phase, three wire, while the required power for shore units is 208 volts, three phase, 60 cycles.

d. SHORE ANTENNA CONTROL AM-1720/URN. - The shore antenna control unit (figure 1-10) consists of the speed control amplifier, the bearing amplifier, fuses, transformers, relays, switches and other miscellaneous associated components. The bearing amplifier is similar to that described above (see paragraph 13c (1)), and the speed control amplifier is as described in paragraph (3) above, except that the power amplifier requirement is a 208-volt, three-phase, four-wire installation.

14. POWER DISTRIBUTION TRANSFORMER TF-235/URN-3.

Power Distribution Transformer TF-235/URN-3 (figure 1-25) is used at shipboard installations to step down the ship's primary power from three-phase, 440-volt to the single-phase, 120-volt required for the operation of the control circuits.

15. REFERENCE DATA.

a. The radio beacon consists of:

(1) Radio Set AN/GRN-9, or Radio Set AN/GRN-9A or Radio Set AN/SRN-6.

(2) Shore antenna group or shipboard antenna group.

(3) Power Distribution Transformer TF-235/URN-3 (shipboard only).

b. Contract Number: NObsr-71385; dated 1 July 1956.

c. Federal Telephone and Radio Company, Clifton, New Jersey, a division of International Telephone and Telegraph Corporation.

d. Inspector of Naval Material, Newark, New Jersey.

e. Number of packages involved (including equipment spares):

(1) Shipboard equipment: 24.

(2) Shore equipment (Navy); 18.

(3) Shore equipment (Air Force): 15.

f. Total cubic contents:

(1) Crated (including equipment spares):

(a) Shipboard: 980.1 cubic feet (approx).

(b) Shore (Navy): 460 cubic feet (approx).

(c) Shore (Air Force): 460.0 cubic feet (approx).

(2) Uncrated (not including equipment spares):

(a) Shipboard: 450 cubic feet (approx).

(b) Shore (Navy): 250 cubic feet (approx).

(c) Shore (Air Force): 250 cubic feet (approx).

g. Total weight:

(1) Crated (including equipment spares):

(a) Shipboard: 8,900 lbs (approx).

(b) Shore (Navy): 6,500 lbs (approx).

(c) Shore (Air Force): 6,000 lbs (approx).

(2) Uncrated (including equipment spares):

(a) Shipboard: 5,000 lbs (approx).

(b) Shore (Navy): 4,000 lbs. (approx).

(c) Shore (Air Force): 3, 500 lbs (approx).

h. Frequency range:

1, 025 mc to 1, 150 mc for receiving

962 mc to 1, 024 mc for transmitting

1, 151 mc to 1, 213 for transmitting

i. Transmitter frequency stability ±25 kc (over the operating range)

Receiver frequency stability ±50 kc (over the operating range)

j. Receiver selectivity: The receiver rejects properly coded interrogations on adjacent channels 80 db above the threshold level of a properly coded interrogation in the pass band. Signals arriving at intermediate frequency are suppressed 80 db. All other spurious responses within the 960-mc to 1, 215-mc band are suppressed 75 db. Low-pass filters are provided for the suppression of radar interference from 1, 650 mc to 10, 500 mc. The suppression will be at least 60 db.

k. The receiver bandwidth is such that the triggering level does not deteriorate by more than three db when its total frequency drift is added directly to an incoming frequency drift of ±70 kc.

l. Receiver triggering level (triggering level is the sensitivity level of the receiver at which a signal will cause the transmitter to fire 60 percent of the time in the absence of reference and identity pulses): A properly coded interrogation 125 db below one watt measured at the input connector on the receiver chassis is sufficient to trigger the transmitter under a condition of no load. A properly coded interrogation 124 db below one watt measured at the same point is sufficient to trigger the transmitter under a condition of full load. The total number of pulses out of the receiver is 2, 700 ±90 pulses for conditions of normal loading or for a 50-percent overload.

m. Receiver echo suppression: Properly spaced pulse-pairs do not trigger the transmitter more than 20 percent of the time for any signal 70 db below one watt or stronger if the amplitude of the second pulse of the pair is at least 25 db below the amplitude of the first pulse.

n. Receiver recovery time: After the second pulse of a correctly coded interrogation which results in decoding, the receiver becomes deactiviated. Provisions are made for adjusting the dead time which follows decoding from 20 to 65 microseconds.

o. Receiver intermediate frequency is 63 mc.

p. Response delay: The radio beacon response delay is 50 ±0. 25 microseconds measured from the leading edge of the second incoming pulse to the

leading edge of the second reply pulse measured at a standard signal strength of 50 db above threshold.

q. Interrogation pulse repetition frequency (PRF): The average PRF of the pulse-pairs which this equipment receives shall be 24 cps from each of 95 interrogating sources. Further the equipment receives, in addition, interrogations at a PRF of 150 cps from each of five other sources. The equipment shall be considered to be operating at full load when receiving interrogations from both PRF sources simultaneously. Under full load conditions and in absence of identification keying, the transmitter shall reply to at least 78 percent of the interrogation.

r. Traffic Capacity: 100 aircraft.

s. Transmitter pulse count limiting: From zero to full load, pulse count limiting is effective to maintain the average number of transmitted pulses constant to within ±2.5 percent of its nominal value.

t. The equipment is adjustable to any one of 126 frequencies in the range listed in paragraph h, above.

u. There is a channel frequency separation of 63 mc between nominal interrogation frequency and nominal reply frequency for all operating channels. There is a channel frequency spacing of 1 mc.

v. The frequencies are direct crystal-controlled. A selection of 126 crystals is provided.

w. The horizontal antenna pattern is a scalloped cardiod.

x. The modulation depth in the horizontal for each modulation frequency is 15 percent +7.5, -0 percent over the respective frequency bands. The modulation frequencies produced by the antenna are 15 cps and 135 cps (the ninth harmonic of 15 cps).

y. Pulse-type transmission at a rate of 3, 600 pulse-pairs per second (includes reference groups and distance replies).

Pulse-pair spacing: 12 microseconds.

Pulse shape:

pulse duration: 3.5 microseconds
pulse rise time: 2.5 microseconds
pulse decay time: 2.5 microseconds

z. Transmitter identification: Identification shall be provided by switching the transmitter from pulse-pairs of random spacing to pulse-pairs at a fixed frequency rate of 1, 350 cps during the key-down position. The first

pulse of the identity occurs 740 ±50 μsec after the first pulse of each auxiliary reference group.

aa. Transmitter reference pulses (for bearing information): At a rate of 135 cps, 120 code groups are transmitted. Each code group consists of six pulse-pairs spaced 24 microseconds apart. At a rate of 15 cps, 15 code groups per second are transmitted. Each of these code groups consist of 12 pulse-pairs spaced 30 microseconds apart.

bb. Squitter rate, which is the rate of random firing of the transmitter in the absence of interrogations. The total number of pulses out of the receiver is 2, 700 ±90 for normal operation.

cc. Transmitter power output is 5 kw peak for Radio Set AN/GRN-9 or 7.5 kw for Radio Set AN/GRN-9A or AN/SRN-6.

dd. Transmitter r-f duty cycle is 3, 600 pulse-pairs per second ±2.5 percent.

ee. Pulse spectrum: The energy level contained in a 0.5-mc bandwidth centered about a frequency ±0.8 mc from the nominal frequency is 60 db below the energy level contained in a 0.5-mc bandwidth centered about the nominal frequency. The energy level contained in a 0.5-mc bandwidth centered about a frequency ±2.0 mc from the nominal frequency is more than 65 db below the energy level contained in a 0.5-mc bandwidth centered about the nominal frequency.

ff. The antenna impedance is 50 ohms.

gg. Synchro input for OSC:

1 speed: 8.7 watts, 0.17 ampere

36 speed: 8.7 watts, 0.17 ampere

hh. Beacon power output:

peak: 5 kw;

average: 120 watts.

ii. Power input requirements:

(1) Radio beacon employing Radio Set AN/GRN-9 (shore, with SAL-39A klystron)

(a) Receiver-transmitter group and power supply-test set group; 208-volt, four-wire, three-phase, 60-cycle; current per phase 20 amperes, 6, 800 watts, 7.2 kva, 0.95 power factor;

(b) Antenna Group:

1. 120-volt, single-phase, 60-cycle, 0.45-ampere, 50-watt, 53.7-kva, 0.93 power factor;

2. 208-volt, three-phase, 60-cycle;

Starting current 18 amperes per phase, 1,800 watts, 2.95 kva 0.60 power factor.

(2) Radio beacon employing Radio Set AN/GRN-9A (shore, with SAL-89 klystron)

(a) Receiver-transmitter group and power supply assembly: 208-volt, four-wire, three-phase, 60-cycle; current per phase 30 amperes, 9,500 watts, 10 kva, 0.95 power factor.

(b) Antenna Group:

1. 120-volt, single-phase, 60-cycle, 0.45-ampere, 50-watt, 53.7-va, 0.93 power factor;

2. 208-volt, three-phase, 60-cycle;

Starting current 18 amperes per phase, 1,800 watts, 2.95 kva, 0.60 power factor.

(3) Radio beacon employing Radio Set AN/SRN-6 (shipboard, with SAL-89 klystron)

(a) Receiver-transmitter group and power supply-test set group: 440-volt, single-phase, 60-cycle; current per phase 20 amperes, 9,000 watts, 9.5 kva, 0.65 power factor.

(b) Antenna Group:

1. 120-volt, single-phase, 60-cycle, 10-ampere, 650-watt, 1.2 kva, 0.54 power factor.

2. 440-volt, three-phase, 60-cycle;

Starting current 6.5 amperes per phase; normal current 5.8 amperes per phase, 1,100 watts, 4.45 kva, 0.25 power factor.

TABLE 1-1. EQUIPMENT SUPPLIED

Qty Per Equip	Qty Per Group	Name	Navy Type Designation	Overall Dimensions*			Volume*	Weight*
				Height	Width	Depth		
RADIO SET AN/GRN-9 (SHORE INSTALLATION)								
1		Receiver-Transmitter	OA-1533/GRN-9	72	25	34 1/8	35.5	1173
	1	Coder-Indicator	KY-235/URN					
	1	Radio Receiver	R-824/URN					
	1	Control Duplexer	C-2226/GRN-9					
	1	Amplifier-Modulator	AM-1702/GRN-9					
	1	Frequency Multiplier-Oscillator	CV-520/GRN-9					
	1	Electrical Equipment Cabinet	CY-2185/GRN-9					
1		Power Supply Assembly	OA-1536/GRN-9	72	25	34 1/8	35.5	1051
	1	Power Supply	PP-1764/URN					
	1	Power Supply	PP-1765/URN					
	1	Power Supply	PP-1766/URN					
	1	Electrical Equipment Cabinet	CY-2188/GRN-9					
1**		Antenna Group (Low Band)	OA-1547/URN					
	1	Antenna	AS-891/URN					
	1	Antenna Pedestal	AB-541/URN					
	1	Electronic Control Amplifier	AM-1720/URN					
1**		Antenna Group (High Band)	OA-1548/URN					
	1	Antenna	AS-892/URN					
	1	Antenna Pedestal	AB-541/URN					
	1	Electronic Control Cabinet	AM-1720/URN					
1		Instruction Book		11	8 1/2			
1		Performance Standards Book						
1		Maintenance Check-Off Book						

* Dimensions in inches, volume in cubic feet and weight in pounds, unless otherwise stated.
** Either the low-band or the high-band group is supplied.

TABLE 1-1. EQUIPMENT SUPPLIED (cont'd)

Qty Per Equip	Qty Per Group	Name	Navy Type Designation	Overall Dimensions* Height	Width	Depth	Volume*	Weight
RADIO SET AN/GRN-9A (SHORE INSTALLATION)								
1		Receiver-Transmitter Group	OA-1534/GRN-9A	72	25	34 1/8	35.5	1173
	1	Coder-Indicator	KY-235/URN					
	1	Radio Receiver	R-824/URN					
	1	Control Duplexer	C-2226/GRN-9					
	1	Amplifier-Modulator	AM-1701/URN					
	1	Frequency Multiplier-Oscillator	CV-589/URN					
	1	Electrical Equipment	CY-2186/GRN-9A					
1		Power Supply Assembly	OA-1537/GRN-9A	72	25	34 1/8	35.5	1051
	1	Power Supply	PP-1763/URN					
	1	Power Supply	PP-1765/URN					
	1	Power Supply	PP-1766/URN					
	1	Electrical Equipment	CY-2189/GRN-9A					
		Antenna Group (Low Band)	OA-1547/URN					
	1	Antenna	AS-891/URN					
	1	Antenna Pedestal	AB-541/URN					
	1	Electronic Control Amplifier	AM-1720/URN					
1**		Antenna Group (High Band)	OA-1548/URN					
	1	Antenna	AS-892/URN					
	1	Antenna Pedestal	AB-541/URN					
	1	Electronic Control Amplifier	AM-1720/URN					
1		Instruction Books		11	8 1/2			
1		Performance Standards Book						
1		Maintenance Check-Off Book						

* Dimensions in inches, volume in cubic feet, and weight in pounds, unless otherwise stated.
** Either the low band or the high band antenna group is supplied

TABLE 1-1. EQUIPMENT SUPPLIED (cont'd)

Qty Per Equip	Qty Per Group	Name	Navy Type Designation	Overall Dimensions* Height	Width	Depth	Volume*	Weight*
RADIO SET AN/SRN-6 (SHIP INSTALLATION)								
1		Receiver-Transmitter Group	OA-1532/SRN-6	72	25	34 1/8	35.5	1173
	1	Coder-Indicator	KY-235/URN					
	1	Radio Receiver	R-824/URN					
	1	Control Duplexer	C-2225/SRN-6					
	1	Amplifier-Modulator	AM-1701/URN					
	1	Frequency Multiplier-Oscillator	CV-589/URN					
	1	Electrical Equipment Cabinet	CY-2184/SRN-6					
1		Power Supply Assembly	OA-1535/SRN-6	72	25	34 1/8	35.5	1051
	1	Power Supply	PP-1763/URN					
	1	Power Supply	PP-1765/URN					
	1	Power Supply	PP-1766/URN					
	1	Electrical Equipment Cabinet	CY-2187/SRN-6					
1**		Antenna Group (Low Band)	OA-1545/SRN-6					
	1	Antenna	AS-889/SRN-6					
	1	Antenna Pedestal	AB-540/SRN-6					
	1	Electronic Control Amplifier	AM-1718/SRN-6					
	1	Electronic Control Amplifier	AM-1719/SRN-6					
	1	Radome	CW-441/SRN-6					
1**		Antenna Group (High Band)	OA-1546/SRN-6					
	1	Antenna	AS-890/SRN-6					
	1	Antenna Pedestal	AB-540/SRN-6					
	1	Electronic Control Amplifier	AM-1718/SRN-6					

* Dimensions in inches, volume in cubic feet and weight in pounds, unless otherwise stated.
** Either the low-band or the high-band group is supplied

TABLE 1-1 EQUIPMENT SUPPLIED (cont'd)

Qty Per Equip	Qty Per Group	Name	Navy Type Designation	Overall Dimensions*			Volume*	Weight*
				Height	Width	Depth		
SHIP INSTALLATION (RADIO SET AN/SRN-6) (cont'd)								
	1	Electronic Control Amplifier	AM-1719/SRN-6					
	1	Radome	GW-441/SRN-6					
1		Power Distribution Transformer	TF-235/URN-3	14 3/8	10 7/8	11 7/16	1 0	110
1		Instruction Book		11	8 1/2			
1		Performance Standards Book						
1		Maintenance Check-Off Book						

* Dimensions in inches, volume in cubic feet and weight in pounds, unless otherwise stated.
** Either the low-band or the high-band group is supplied.

TABLE 1-2. EQUIPMENT REQUIRED

Qty Per Equip	Name	Navy Type Designation	Overall Dimensions*			Volume*	Weight*
			Height	Width	Depth		
SPECIAL TEST EQUIPMENT SUPPLIED BUT NOT PART OF AN/GRN-9, AN/GRN-9A, AN/SRN-6							
1	Power Meter-Pulse Counter	TS-891/URN-3	14 13/32	9 1/2	26 3/4	3650	31.5
1	Switch-Test Adapter	SA-420/URN-3	5 7/8	9 3/4	15 5/8	890	15
2	Instruction Book	NAVSHIPS 92809	11 1/2	9	5/16	.01	.3
1	Oscilloscope	OS-54/URN-3	14 13/32	13 1/2	26 1/2	3	87
2	Technical Manual	NAVSHIPS 92778	11 1/2	9	1/2	03	8
1	Pulse Analyzer Signal Generator	TS-890/URN-3	14 5/8	13 1/2	24	2 72	95
2	Technical Manual	NAVSHIPS 92819	11	9	1/2	.03	1
1	Pulse Sweep Generator	SG-121A/URN-3	14 19/32	9 1/2		2 1	45
2	Technical Manual	NAVSHIPS 92745	11 1/2	8 1/2	1/2	.025	0 75

TABLE 1-3. SHIPPING DATA

Box No	Contents		Overall Dimensions*			Volume*	Weight*
	Name	Designation	Height	Width	Depth		
SHORE INSTALLATION (RADIO SET AN/GRN-9)							
	Receiver-Transmitter Group	OA-1533/GRN-9	90	44	43	105	1850
	Power Supply Assembly	OA-1536/GRN-9	90	44	43	105	1720
	Tube, Klystron	SAL-39A	30	20	20	7.0	78
	Electronic Control Amplifier	AM-1720/URN					
**	Low Band Antenna						
	Antenna	AS-891/URN					
	Antenna Pedestal	AB-541/URN					
**	High Band Antenna						
	Antenna	AS-892/URN					
	Antenna Pedestal	AB-541/URN					
	Equipment Spares						
SHORE INSTALLATION (RADIO SET AN/GRN-9A)							
	Receiver-Transmitter Group	OA-1534/GRN-9A	90	44	43	105	1850
	Power Supply Assembly	OA-1537/GRN-9A	90	44	43	105	1720
	Tube, Klystron	SAL-89					
	Electronic Control Amplifier	AM-1720/URN					
**	Low Band Antenna						
	Antenna	AS-891/URN					
	Antenna Pedestal	AB-541/URN					
**	High Band Antenna						
	Antenna	AS-892/URN					
	Antenna Pedestal	AB-541/URN					
	Equipment Spares						

* Dimensions in inches, volume in cubic feet and weight in pounds, unless otherwise stated
** Either low band or high band antenna is shipped.

TABLE 1-3. SHIPPING DATA (Cont'd)

Box No	Contents		Overall Dimensions*			Volume*	Weight*
	Name	Designation	Height	Width	Depth		
SHIP INSTALLATION (RADIO SET AN/SRN-6)							
	Receiver Transmitter Group	OA-1532/SRN-6	90	44	43	105	1850
	Power Supply Assembly	OA-1535/SRN-6	90	44	43	105	1720
	Tube, Klystron	SAL-89					
	Electronic Control Amplifier	AM-1718/SRN-6					
	Electronic Control Amplifier	AM-1719/SRN-6					
	Radome	CW-441/SRN-6					
	Power Distribution Transformer	TF-235/URN-3					
**	Low Band Antenna						
	Antenna	AS-889/SRN-6					
	Antenna Pedestal	AB-540/SRN-6					
**	High Band Antenna						
	Antenna	AS-890/SRN-6					
	Antenna Pedestal	AB-540/SRN-6					
	Equipment Spares						

* Dimensions in inches, volume in cubic feet and weight in pounds, unless otherwise stated.
** Either the low band or high band antenna is shipped.

TABLE 1-4. ELECTRON TUBE AND GERMANIUM DIODE COMPLEMENT FOR RADIO SETS AN/SRN-6, AN/GRN-9 AND AN/GRN-9A

UNIT	NUMBER OF TUBES AND GERMANIUM DIODES OF TYPE INDICATED.																																	TOTAL PER UNIT		
	1N21C	1N25	1N69	1N126	1N256	2C39A	4-1000A	5D22	5R4WGB	6AH6	6AR6	6J4WA	6X4W	6V3A	12AT7WA	SAL39A	SAL89	371B	829B	836	5651WA	5654/6AK5W	5670	5687WA	5725/6AS6W	5726/6AL5W	5814A	6005/6AQ5W	6080WA	6293	6626/0A2WA	6627/0B2WA	8020	AN/SRN-6	AN/GRN-9	AN/GRN-9A
Radio Receiver R-824/URN	2			5					1			1	1		3							8	3		2	3		1	1			2		33	33	33
Coder Indicator KY-235/URN			6						1	1			1		7								5	3					1			1		26	26	26
Amplifier-Modulator AM-1702/GRN-9							1	1			3					1		1										1							8	
Amplifier-Modulator AM-1701/URN					2												1				1		1	1										6		6
Frequency Mult. Osc. CV-590/GRN-9		2	2			6						2		1								2	2	4			1			4					26	
Frequency-Mult. Osc. CV-589/URN		2	2			6						2		1								2	2	4			1			5				27		27
Power Supply PP-1766/URN									3						2				3		2													10	10	10
Power Supply PP-1765/URN															1				5	2											5			13	13	13
Power Supply PP-1764/URN																																	6		6	
Power Supply PP-1763/URN																																	6	6		6
Totals Radio Set AN/SRN-6	2	2	8	5	2	6	-	-	5	1	-	3	2	1	13	-	1	-	8	2	3	10	11	8	2	3	1	1	2	5	5	3	6	121		
Radio Set AN/GRN-9	2	2	8	5	-	6	1	1	5	1	3	3	2	1	13	1	-	1	8	2	2	10	10	7	2	3	1	2	2	4	5	3	6		122	
Radio Set AN/GRN-9A	2	2	8	5	2	6	-	-	5	1	-	3	2	1	13	-	1	-	8	2	3	10	11	8	2	3	1	1	2	5	5	3	6			121

Note: Crystal detector assembly E1152, one of which is supplied with each radio set, contains one 1N25 diode.

TABLE 1-5. RECTIFIERS USED IN ANTENNA CONTROL UNITS

NUMBER	TYPE	NUMBER	TYPE
CR2001	1N538	CR2128	1N538
CR2020	1N538	CR2129	1N538
CR2021	1N538	CR2130	1N538
CR2032	1N538	CR2131	1N538
CR2089	1N538	CR2132	1N538
CR2093	1N538	CR2133	1N538
CR2101	1N538	CR2134	1N538
CR2102	1N538	CR2135	1N538
CR2103	1N538	CR2136	1N538
CR2104	1N538	CR2137	1N538
CR2105	1N538	CR2138	1N538
CR2106	1N538	CR2139	1N538
CR2107	1N538	CR2140	1N538
CR2108	1N538	CR2141	1N538
CR2109	1N540	CR2142	1N538
CR2110	1N540	CR2143	1N538
CR2111	1N248A	CR2144	1N538
CR2112	1N248A	CR2145	1N538
CR2113	1N248A	CR2146	Z2DP
CR2114	1N248A	CR2002	1N538
CR2115	1N248A	CR2003	1N538
CR2116	1N248A	CR2004	1N538
CR2117	1N538	CR2005	1N538
CR2118	1N538	CR2006	1N538
CR2119	1N538	CR2007	1N538
CR2120	1N538	CR2008	1N538
CR2121	1N538	CR2009	1N538
CR2122	1N540	CR2010	1N538
CR2123	1N540	CR2011	1N538
CR2126	1N538	CR2012	1N538
CR2127	1N538	CR2013	1N538

TABLE 1-5. RECTIFIERS USED IN ANTENNA CONTROL UNITS (Cont'd)

NUMBER	TYPE	NUMBER	TYPE
CR2014	1N538	CR2048	TM-7
CR2015	1N538	CR2049	TM-7
CR2016	1N538	CR2050	TM-7
CR2017	1N538	CR2051	TM-7
CR2018	1N538	CR2052	TM-7
CR2019	1N538	CR2055	Z2DP
CR2022	1N538	CR2083	1N248
CR2023	1N538	CR2084	1N248
CR2024	1N538	CR2085	1N248
CR2025	1N538	CR2086	1N248
CR2026	1N538	CR2087	1N248
CR2027	1N538	CR2088	1N248
CR2028	1N538	CR2090	1N538
CR2029	1N538	CR2091	1N538
CR2030	1N538	CR2092	1N538
CR2031	1N538		
CR2033	1N253		
CR2034	1N253		
CR2035	1N253		
CR2036	1N253		
CR2037	1N253		
CR2038	1N253		
CR2039	1N253		
CR2040	1N253		
CR2041	1N253		
CR2042	1N253		
CR2043	1N253		
CR2044	1N253		
CR2045	TM-7		
CR2046	TM-7		
CR2047	TM-7		

NOTE

The illustration listed below was not available at the time this publication was printed.

Figure 1-1. Radio Beacon Components, Composite View

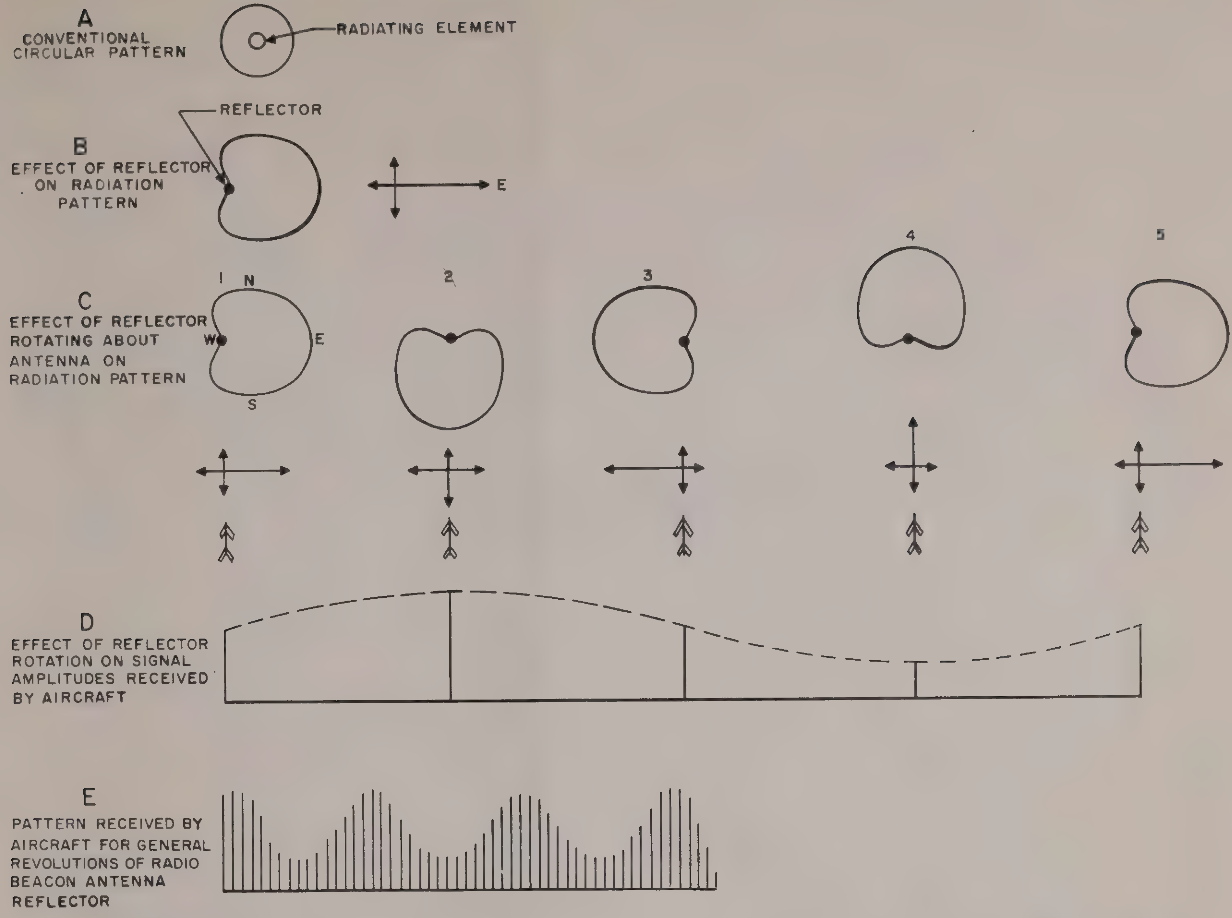

Figure 1-2. Employment of North Reference Burst to Mark Bearing of Aircraft Relative to the Radio Beacon

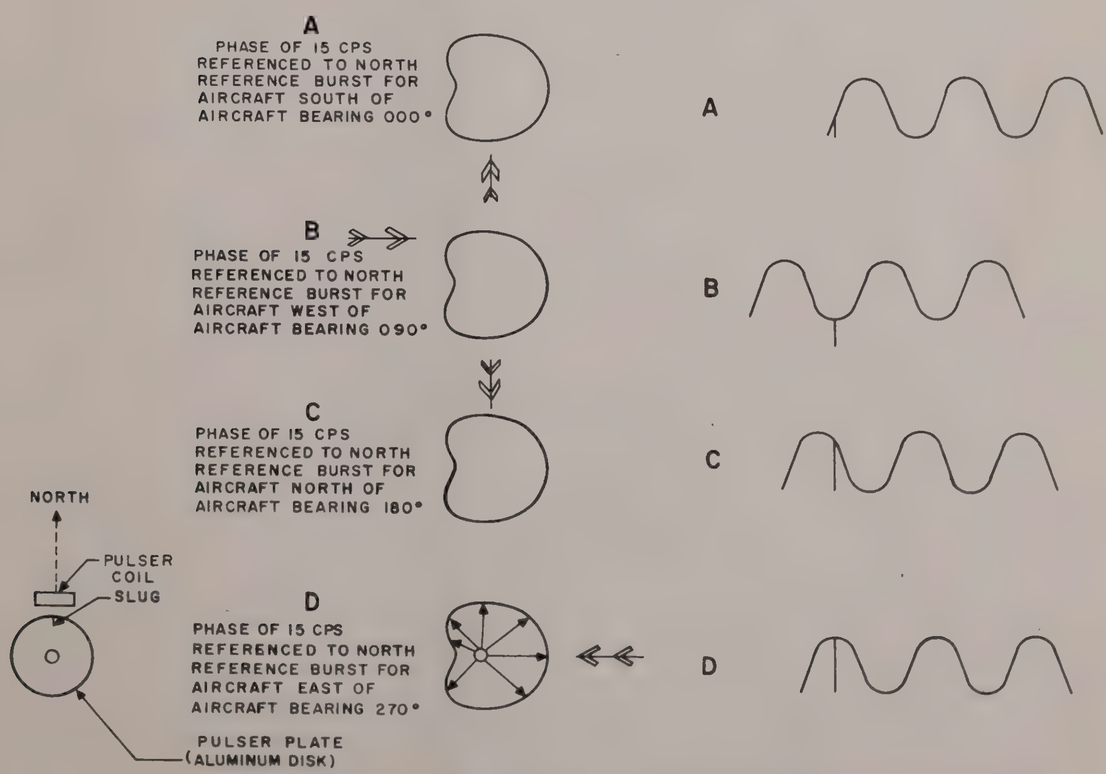

Figure 1-3. Development of Radio Beacon Radiation Pattern

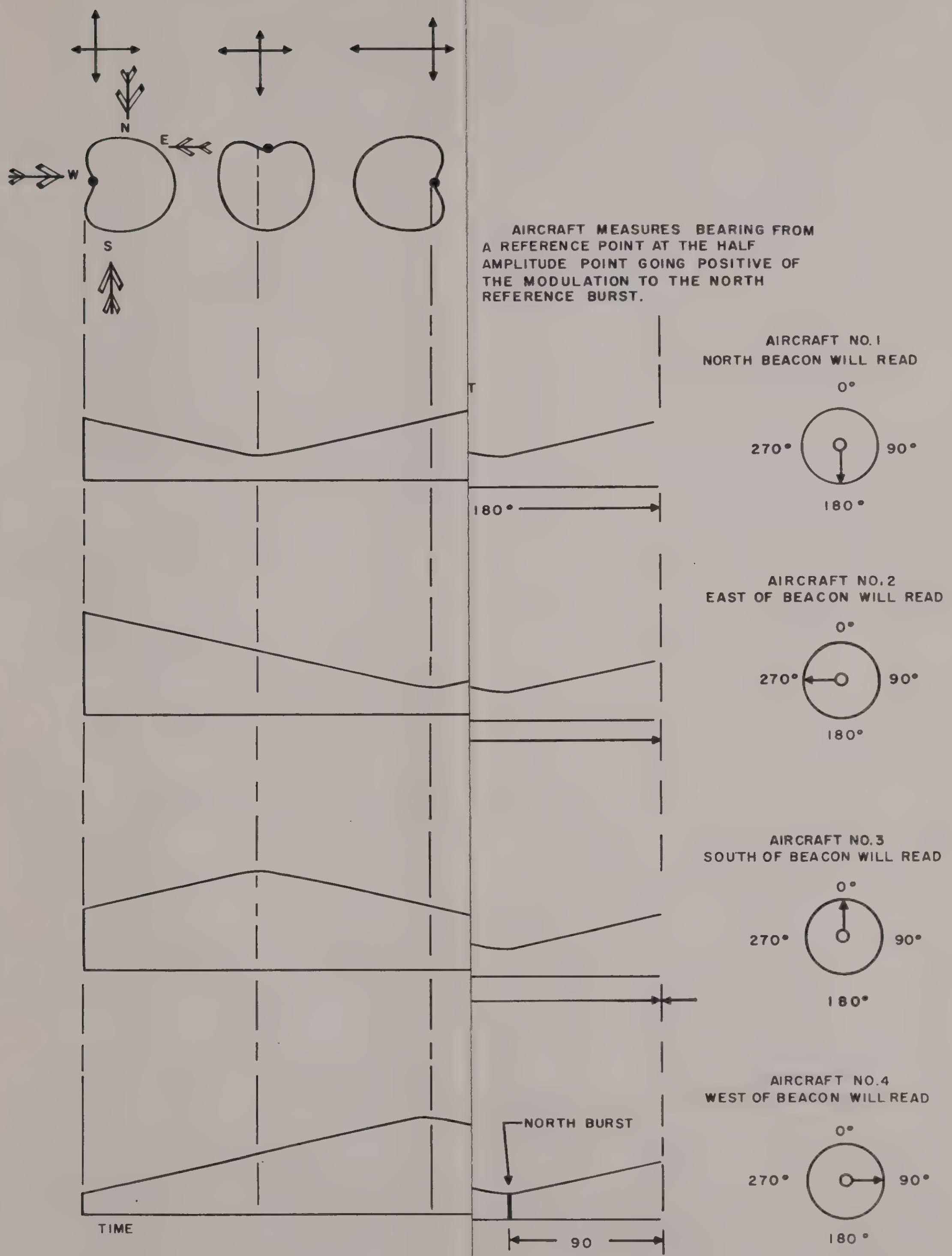

Figure 1-4. Comparison of Bearing Information by Aircraft in Different Geographical Positions Relative to the Radio Beacon

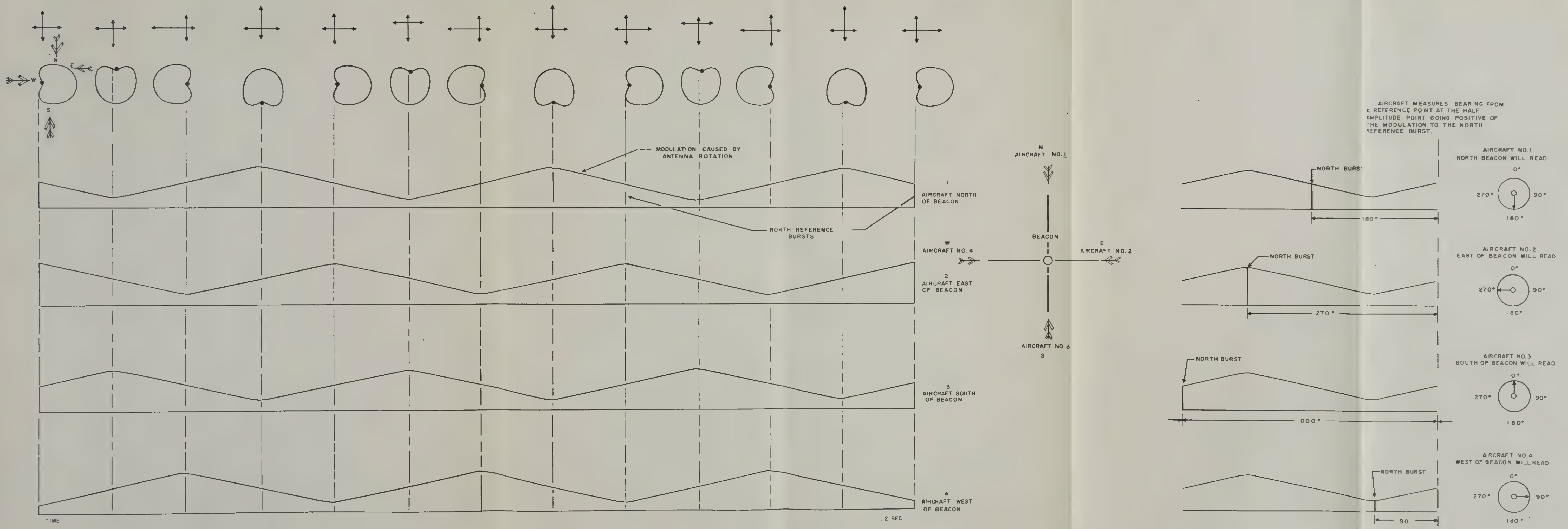

Figure 1-4. Comparison of Bearing Information by Aircraft in Different Geographical Positions Relative to the Radio Beacon

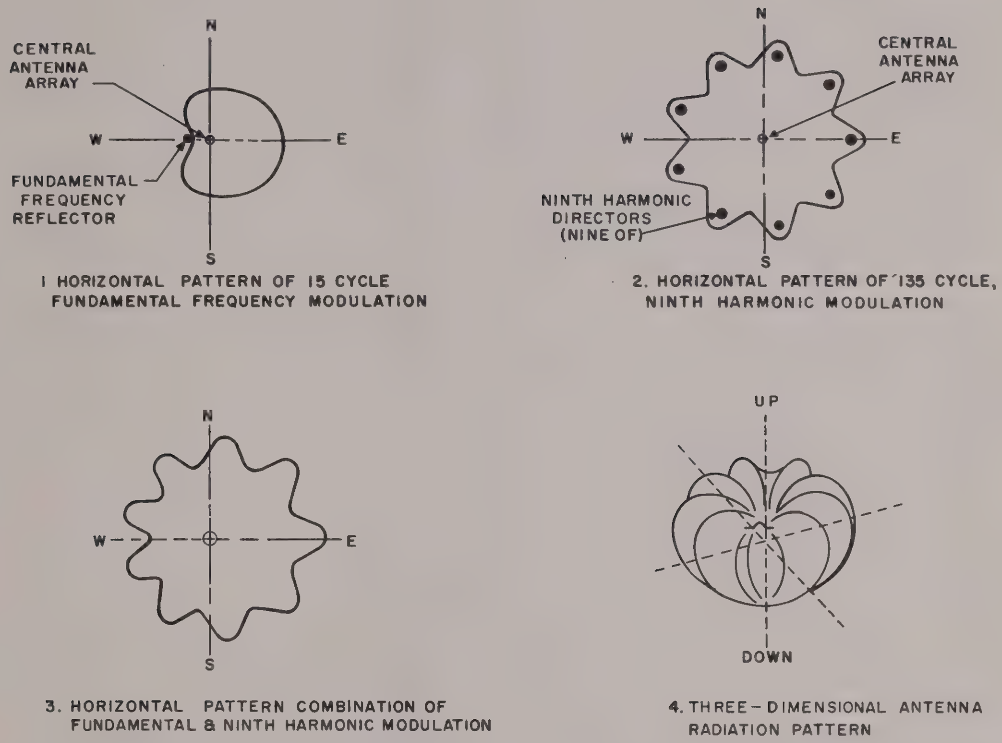

Figure 1-5. Development of Composite Radiation Pattern

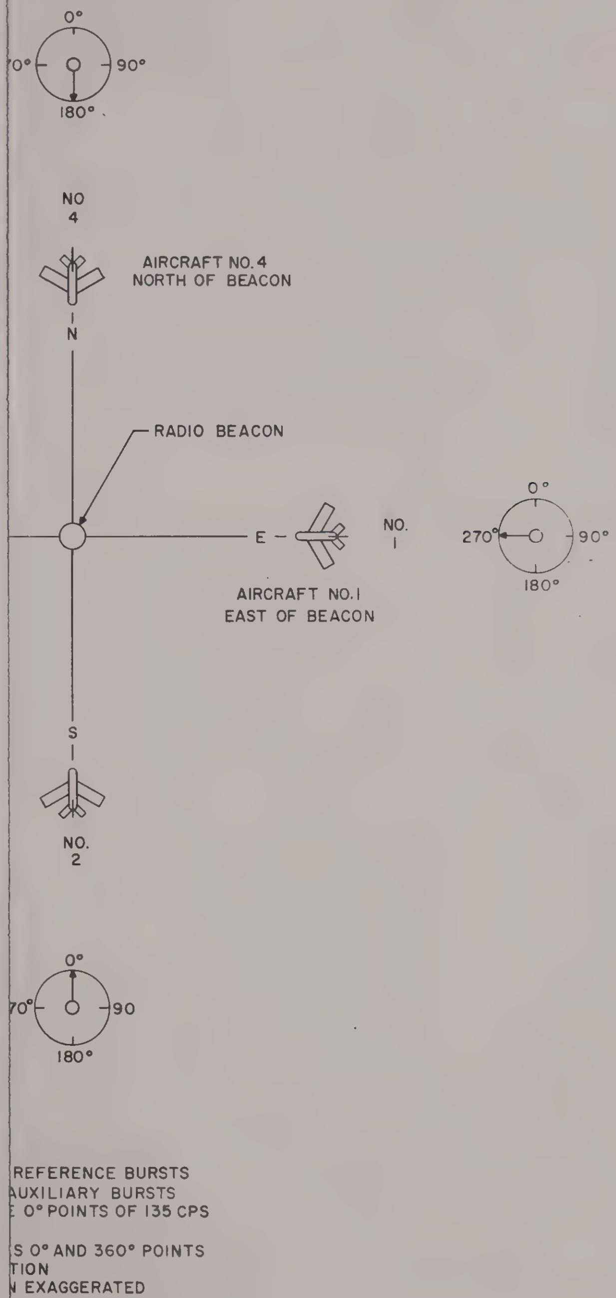

Figure 1-6. Compositing the 15-CPS and 135-CPS Amplitude Modulation and Burst Signal Elements into Bearing Information

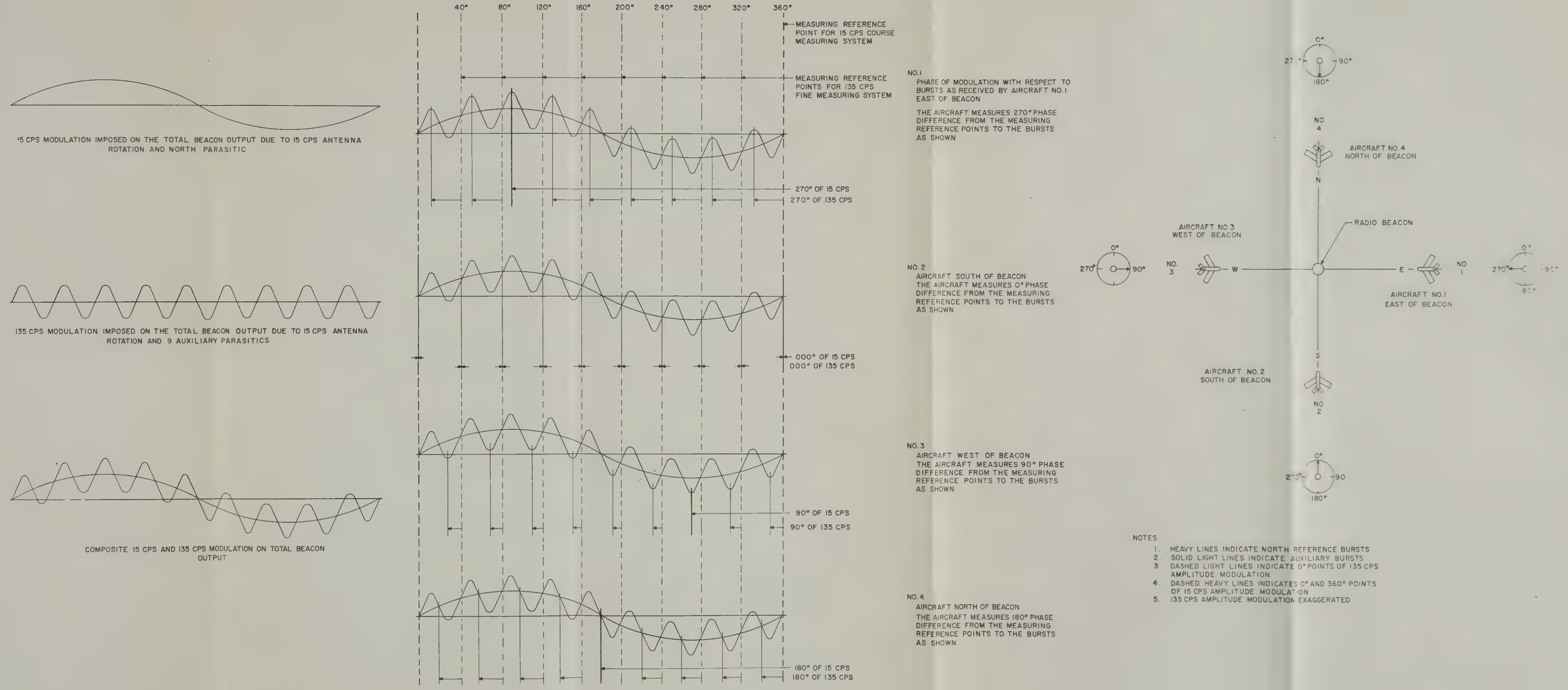

Figure 1-6. Compositing the 15-CPS and 135-CPS Amplitude Modulation and Burst Signal Elements into Bearing Information

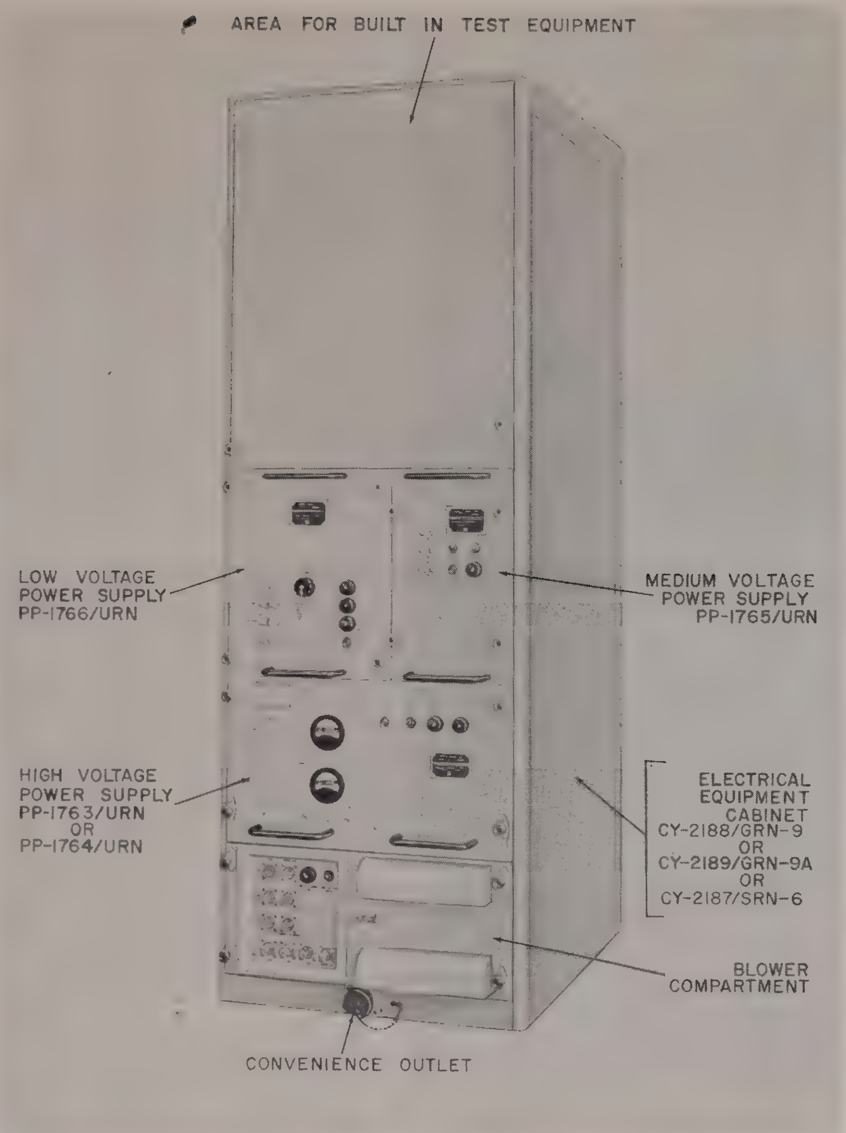

Figure 1-8. Power Supply Assembly OA-1535/SRN-6, OA-1536/GRN-9, or OA-1537/GRN-9A, Overall View

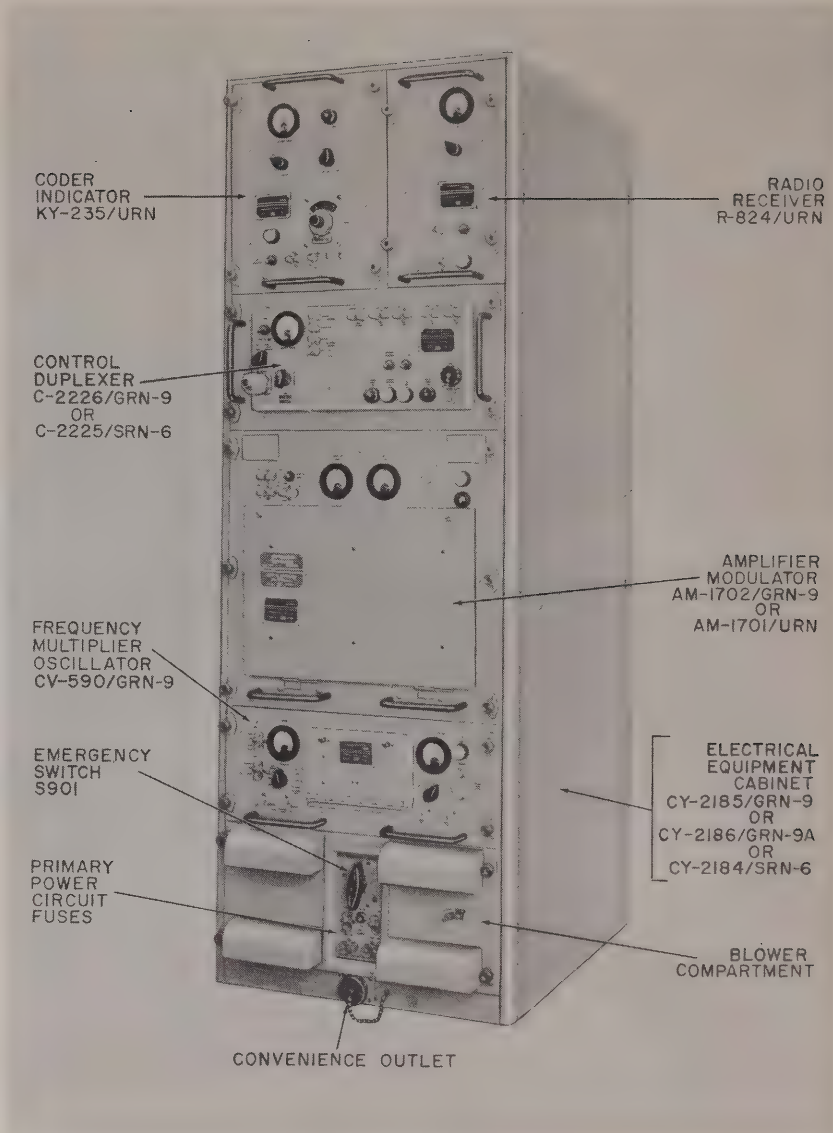

Figure 1-7. Receiver-Transmitter Group OA-1532/SRN-6, OA-1533/GRN-9, or OA-1534/GRN-9A, Overall View

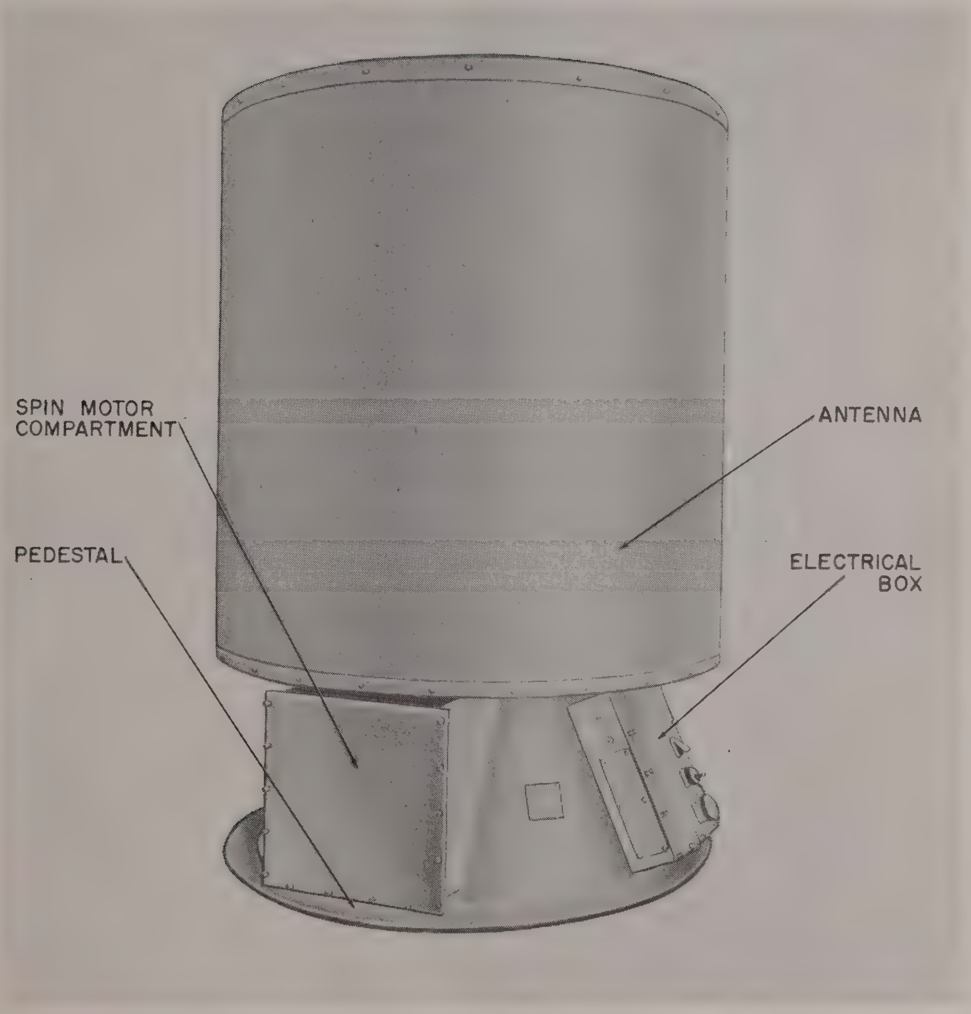

Figure 1-9. Shore Antenna Assembly OA-1547/URN, Overall View

NOTE

The illustrations listed below were not available at the time this publication was printed.

Figure 1-10. Amplifier, Electronic Control AM-1720/URN (Shore Antenna Control Unit)

Figure 1-11. Shipboard Antenna Assembly, Antenna Group OA-1545/SRN-6 (Low Band), Overall View

Figure 1-12. Amplifier, Electronic Control AM-1719/SRN-6, (Shipboard), Overall View

Figure 1-13. Amplifier, Electronic Control AM-1718/SRN-6, (Shipboard Speed Control Unit), Overall View

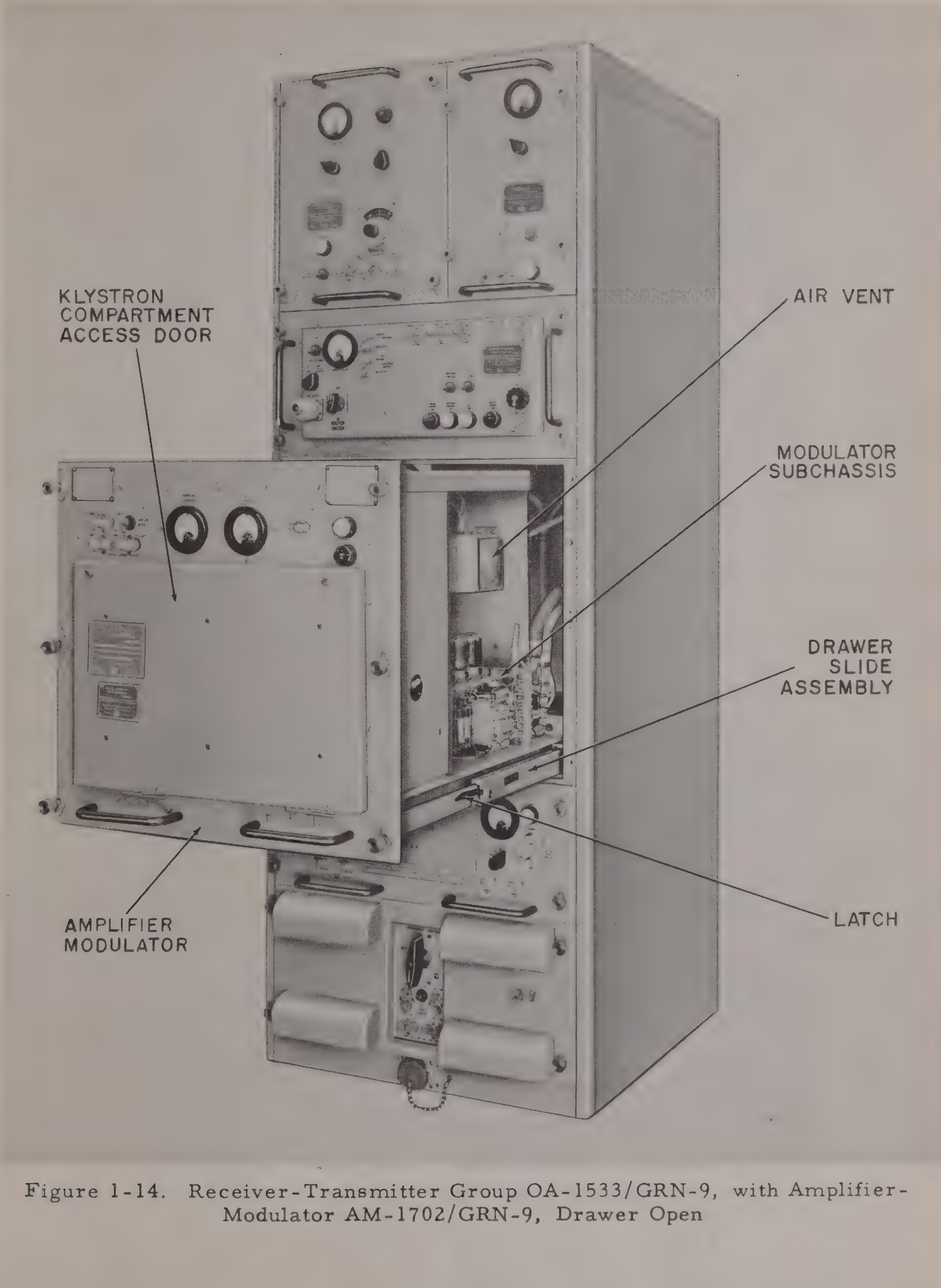

Figure 1-14. Receiver-Transmitter Group OA-1533/GRN-9, with Amplifier-Modulator AM-1702/GRN-9, Drawer Open

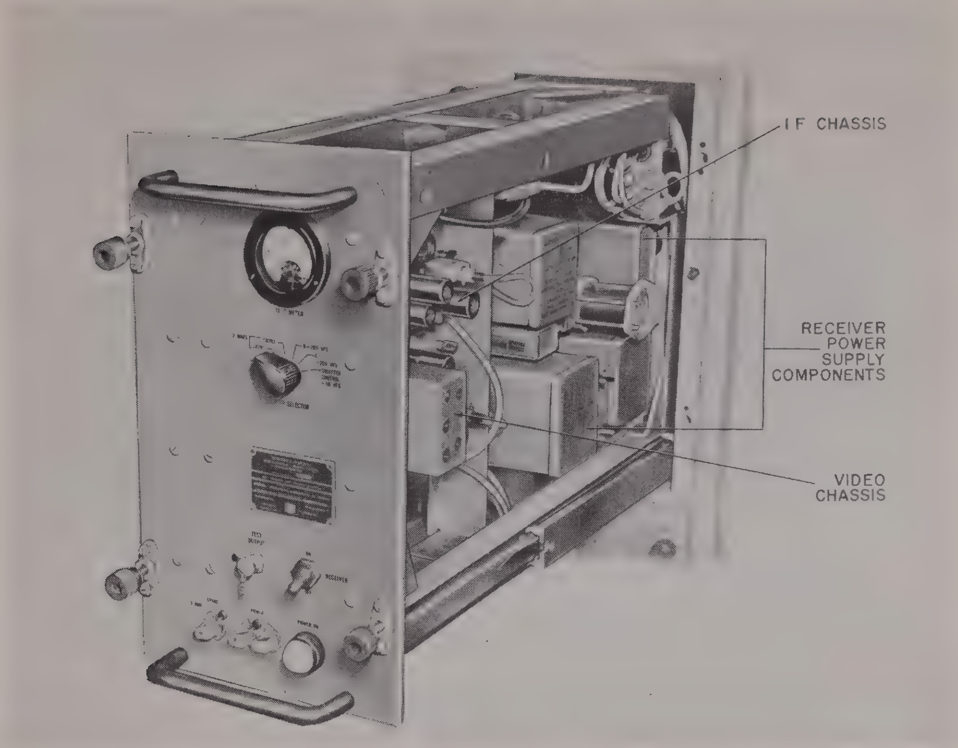

Figure 1-15. Radio Receiver R-824/URN, Overall View

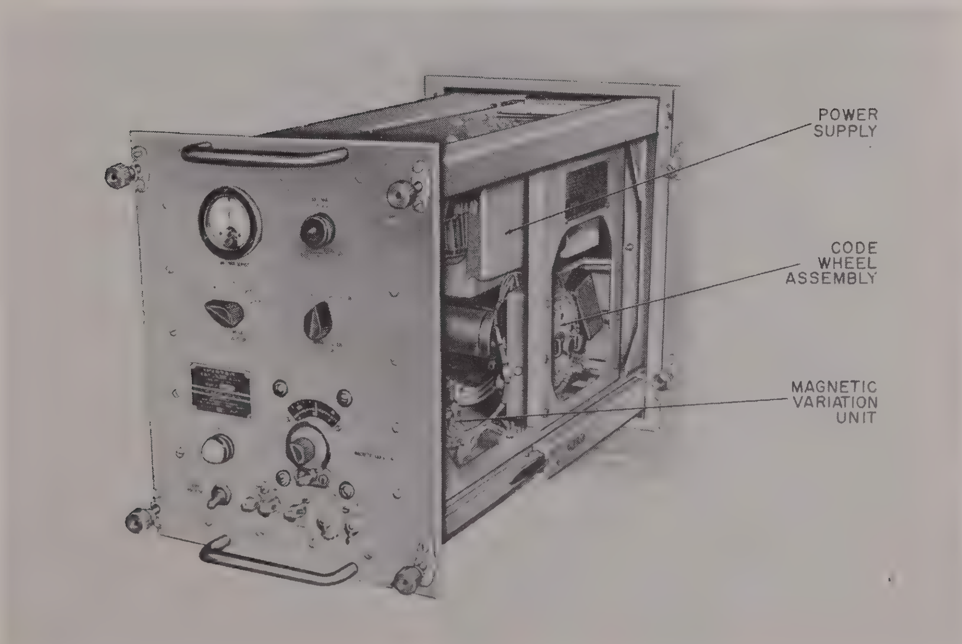

Figure 1-16. Coder Indicator KY-235/URN, Overall View

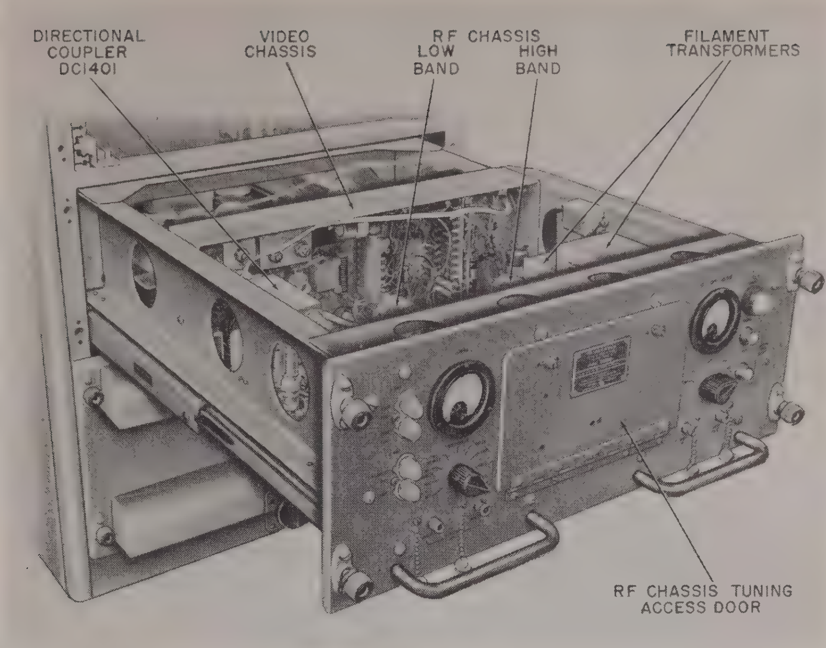

Figure 1-17. Frequency Multiplier-Oscillator CV-590/GRN-9 or CV-589/URN, Overall View

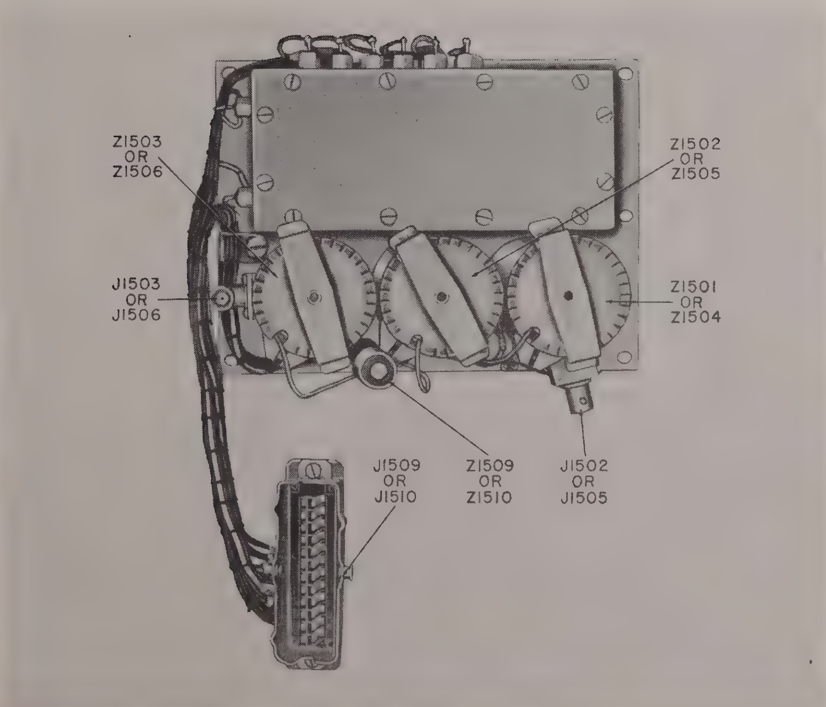

Figure 1-18. Frequency Multiplier-Oscillator CV-589/URN and CV-590/GRN-9, R-f Chassis, Bottom View

NOTE

The illustration listed below was not available at the time this publication was printed.

Figure 1-19. Amplifier-Modulator AM-1701/URN, Overall View

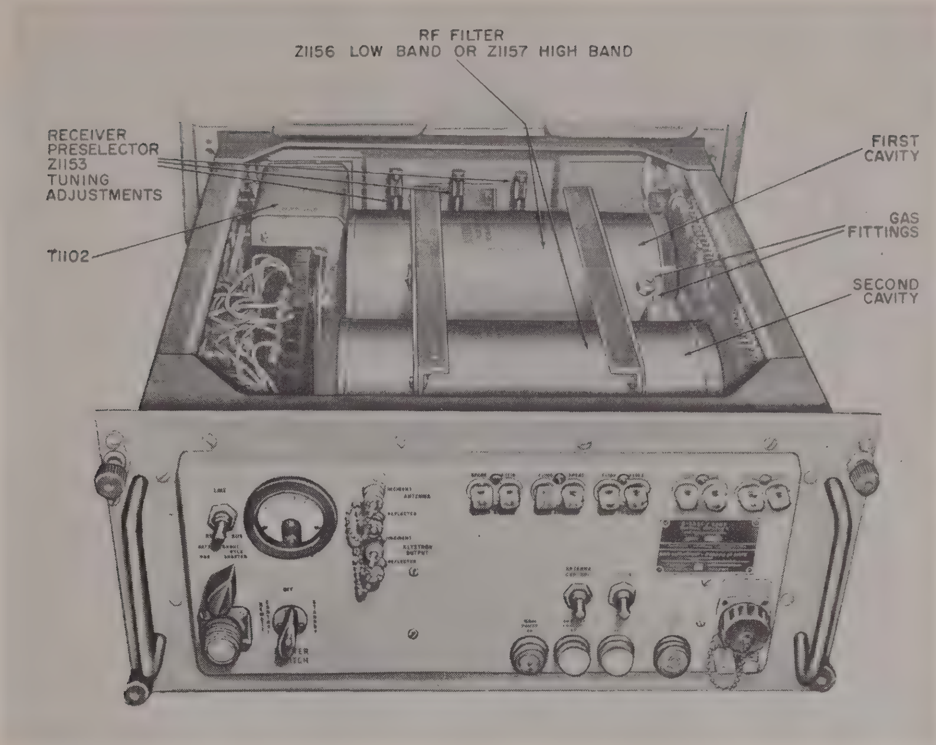

Figure 1-20. Control-Duplexer C-2225/SRN-6 or C-2226/GRN-9, Overall View

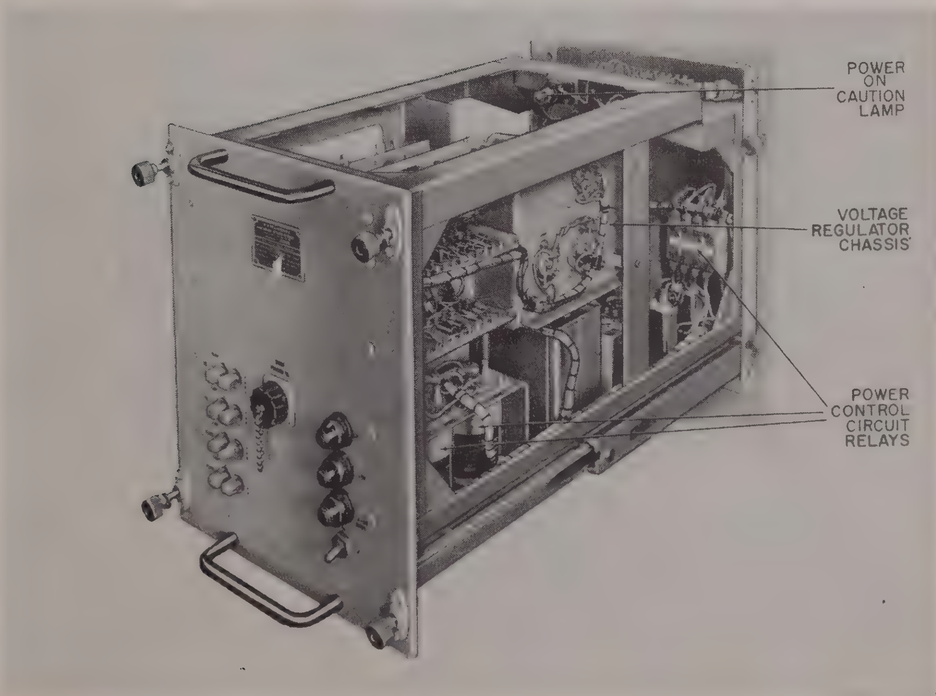

Figure 1-21. Low Voltage Power Supply PP-1766/URN, Overall View

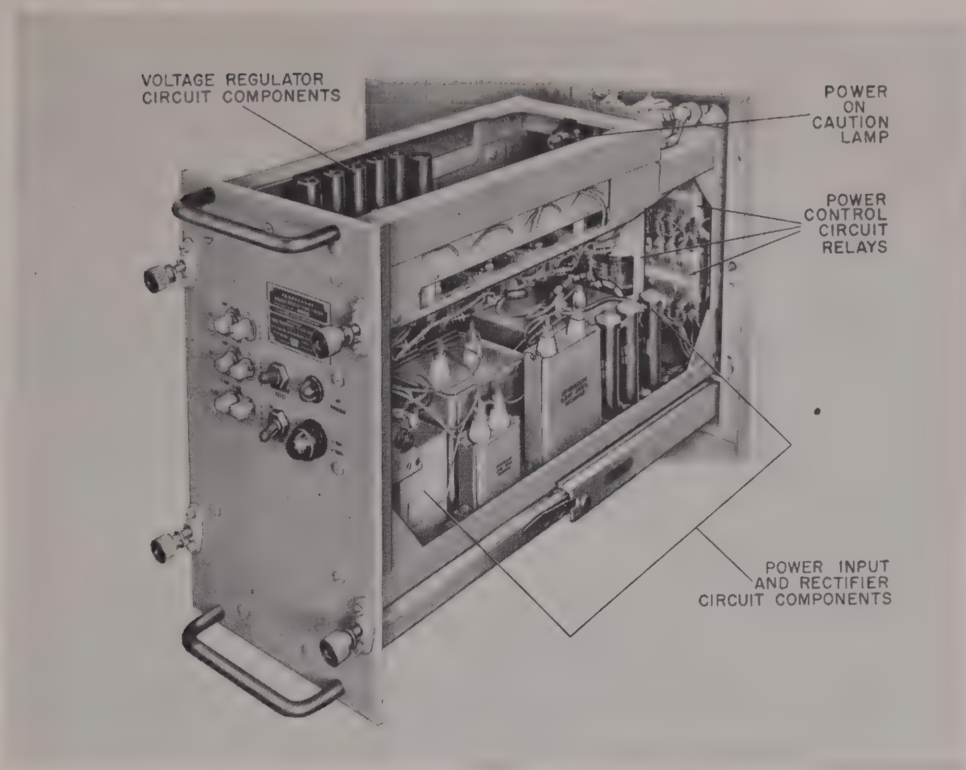

Figure 1-22. Medium Voltage Power Supply PP-1765/URN, Overall View

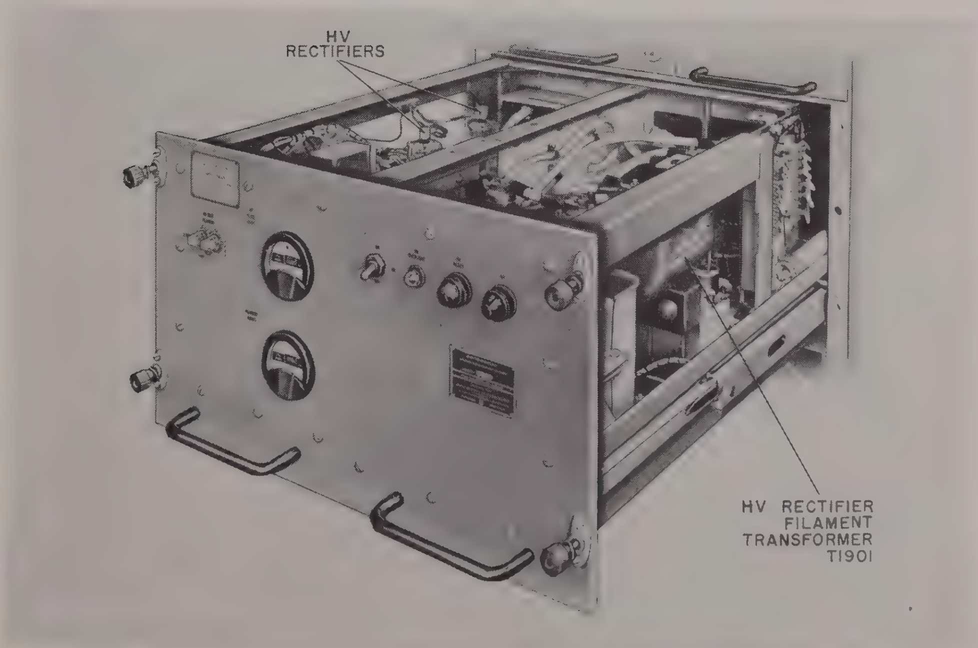

Figure 1-23. High Voltage Power Supply PP-1763/URN or PP-1764/URN, Overall View

NOTE

The illustrations listed below were not available at the time this publication was printed.

Figure 1-24. Antenna Assembly, Cutaway View

Figure 1-25. Transformer, Power Distribution TF-235/URN, Shipboard Unit

SECTION 2

THEORY OF OPERATION

1. GENERAL DESCRIPTION OF CIRCUITS.

Refer to figure 2-1, Radio Set AN/GRN-9, Simplified Overall Block Diagram.

a. RECEIVER. - Distance interrogation pulse-pairs, received by the antenna and passed through the duplexer, pass through a low-pass filter to the mixer stage of the receiver. The low-pass filter rejects frequencies between 1,650 and 10,000 megacycles to prevent interference from other pulse-producing equipment operating in the band. To prevent interference from the transmitter portion of the radio set, a blanking pulse blanks out the receiver whenever the transmitter klystron is operating.

The receiver uses the output from the frequency multiplier-oscillator section of the transmitter as its local oscillator signal. The mixer and preamplifier consists of a balanced hybrid T-type mixer and a three-stage preamplifier. The local oscillator signal is fed into one arm of the mixer, and the interrogation r-f pulses are fed into the other arm. The resultant intermediate frequency of 63 megacycles is amplified in the three-stage preamplifier.

From the preamplifier, the i-f amplifier receives the interrogation pulses and random noise pulses at the intermediate frequency. These voltages are amplified to a level sufficient to operate the Ferris discriminator, which detects the interrogation and random noises pulses at 63 mc and effects adjacent and near-adjacent channel rejection. The output of the Ferris discriminator, a video signal, is fed to the receiver video amplifiers. Also employed in the i-f amplifier are echo-suppression circuits, which permit operation in areas where large reflecting objects are present. Squitter-control voltage, fed into the i-f amplifier from the squitter voltage generator, maintains the receiver output at 2,700 (±90) pulses per second.

The video amplifiers receive the i-f amplifier output (noise and interrogation pulses) and further amplify these video signals to a level that can operate the coincidence-type decoder. The decoder functions to produce a single pulse for each input pulse-pair having pulses separated by 12 microseconds. The

decoding of each pulse pair is followed by a 40-μsec blanking of the receiver to insure that the 2, 700 pulses at the receiver output will be distributed over a period of one second. Although the squitter control circuits set the pulse output of the receiver at 2, 700±90 per second, the entire pulse output for one second could occur during the first quarter-second, likewise the entire pulse output for the following second could occur during the second quarter-second. This would leave a period of one and one-half seconds during which there would be no output from the receiver. By introducing a blanking period of 40 μsec after the decoding of each pulse pair, the minimum spacing between receiver output pulses is set at 65 μsec, owing to the total effect of the 40-μsec blanking period plus the coding time of 12 μsec, and the 10-μsec blanking of the receiver by the transmitter.

During the transmission of output pulses by the transmitter, a sample of the 10-μsec pulse generated in the frequency multiplier-oscillator video chassis is fed to the receiver blanking gate to disable the receiver. Disabling the receiver during the transmission of output pulses prevents the radio set from responding to its own transmitted signal. In addition, a pulse-counter circuit produces a squitter-control voltage which is fed back to the i-f amplifier. This voltage controls the gain of the i-f amplifier circuit so that decoding of 12-microsecond-interval pulse-pairs (interrogations) and of random noise groups effects the desired output of 2, 700 pulses per second. When the rate of interrogation pulse-pairs falls below 2, 700 pulse-pairs per second, i-f amplification is increased until a sufficient number of random noise pulse-pairs are decoded to maintain receiver output at the required rate. Under normal conditions the maximum interrogation rate should not be above 2, 500 pulse-pairs per second.

The pulse output of the decoder triggers a one-shot multivibrator having three outputs: one output initiates a blanking gate to the video amplifiers, the second output initiates the squitter control voltage to the i-f amplifiers, and the third output is used to drive the receiver output cathode followers. The output of the cathode followers is fed to the coder-indicator.

b. CODER-INDICATOR. - The coder-indicator produces a multiplexed output signal consisting of three components: reference burst, distance reply pulses, and beacon identification code tone pulses. Generation of the reference bursts component has priority over generation of all other output components.

For each revolution of the antenna, the 135-cps reference burst generator receives eight trigger pulses from the antenna and the 15-cps reference burst

generator receives one 15-cps trigger pulse. The 135-cps trigger pulse applied to the 135-cps reference burst generator is approximately 12 v peak to peak and 150 microseconds wide. Upon reception of the 135-cps trigger pulse a reference burst of six pulses spaced 24 microseconds apart is generated.

The 15-cps reference pulses are generated in a similar manner in the 135-cps reference burst generator. The 15-cps reference burst must consist of 12 pulses, 30 microseconds apart. At the input to the shaping amplifier stage the 15-cps and 135-cps reference pulse groups are mixed. From this point on, both code groups pass through the same stages. This is possible because two reference pulse groups never occur simultaneously.

For each reference burst sent to the shaping amplifiers, a blocking gate is sent to the priority gate blocked amplifier which gates out the identification call and distance reply signals. This establishes the priority of reference bursts over all other signals.

The output of the shaping amplifiers drives encoding delay line DL601, which is inductively tapped at 32 μsec delay and at 44 μsec delay. The encoding delay line introduces the major portion of the standard zero distance delay for distance reply pulses and provides a pulse-pair having a 12-microsecond spacing for each pulse fed into the delay line.

The doubled pulsed output of DL601 is coupled to the output amplifier stages. These stages provide gain in signal amplitude, improvement in waveshape, uniformity of output, and impedance matching to the transmitter input.

The other coder-indicator output components are distance reply pulses and beacon identification code tone pulses. Selection of one or the other of these components is controlled by the mechanical switching action of the identification call mechanical keyer. The voltage on pin 10 of TB604 is 0 volts with a -50-volt gate appearing whenever the code keying wheel indicates that a 1, 350 -cps tone dot or dash is to be sent.

During transmission of identification code characters the -50-volt gate cuts off the gate blocked distance reply amplifier which normally passes distance reply pulses from the receiver to the priority gate blocked amplifier.

Simultaneously, the -50-volt gate keys on the normally cutoff 1, 350-cps tone signal and permits the 1, 350-cps tone output to be sent to the priority gate blocked amplifier.

In this manner, the code keying wheel controls the selection of the code and establishes the priority of the 1, 350-cps tone oscillator signal over the distance reply signals.

The priority gate blocked amplifier passes the identification code and distance reply signals to the shaping amplifiers. However, whenever a reference burst is generated, a blocking gate is applied to the priority gate blocked amplifier, cutting it off and establishing priority of the reference burst over the identification code and distance reply signals.

All signals from the priority gate blocked amplifier to the shaping amplifiers are shaped, double-encoded, amplified, and sent to the transmitter as components of a multiplexed signal in the same manner as described previously for the reference bursts signals.

Not dependent on the signal output of any other coder-indicator circuit is the antenna synchronization 1,350-cps oscillator. The frequency output of this oscillator is controlled by a 1,350-cps tuning fork. The oscillator output is used to check the speed of rotation of the antenna.

c. TRANSMITTER.

(1) RADIO SET AN/GRN-9. - The output of the coder-indicator, consisting of 3,600 pulse-pairs per second, is fed to the frequency multiplier-oscillator video chassis in the transmitter. From each pulse fed into the frequency multiplier-oscillator, two video pulses are developed. One pulse, called the klystron gate pulse, is a 10-μsec square pulse that is amplified in succeeding stages of the transmitter to a level sufficient to key the high voltage applied to the klystron. The second pulse, called the 3.5-μsec shaped pulse, is a specially shaped video pulse having a relatively long rise and decay time in order that the final r-f output pulse will occupy a minimum of spectrum. In passing through the shaper network, the 3.5-microsecond shaped pulse is delayed. To insure that it will arrive at the klystron coincident with the center of the 10-microsecond klystron gate pulse, that pulse is also delayed in the video circuits of the frequency multiplier-oscillator. The total delay of interrogation pulses, called the zero distance time delay, consists of the sum of delays introduced in the coder-indicator and frequency multiplier-oscillator, and is equal to 50 μsec.

In addition to developing the required video modulating pulses, the frequency multiplier-oscillator portion of the transmitter provides an r-f carrier signal of sufficient power to drive the SAL-39A klystron in the final power output stage.

The r-f output of the frequency multiplier chain is initiated by a "Butler" or "Navy Type" crystal oscillator and frequency doubler stage. The basic oscillator frequency is multiplied 24 times; three doublers and one tripler are

employed to accomplish this. One output of the final tripler is fed to the mixer stage of the receiver and is used as the local oscillator signal. The other output of the final tripler is fed to a pair of pulsed r-f amplifiers connected in cascade. Also fed to the r-f amplifiers are the specially shaped 3.5-microsecond pulses developed in the shaped pulse generator. The r-f amplifiers are plate-modulated by the shaped 3.5-microsecond pulses. The pulsed r-f output is coupled to the klystron accelerator grid input and provides up to 100 watts peak drive power to the klystron.

The clipper amplifier and shunt regulator stages shape and amplify the 10-microsecond gate pulses used to key the klystron beam power amplifier which produces a high-power klystron beam pulse for each gate pulse received. This pulse is applied to the cathode of the klystron as a negative 10,500-volt keying pulse.

Coincident with the timing of the center of the klystron beam pulse appearing at the klystron cathode, a modulated r-f pulse from the second keyed r-f amplifier appears at the klystron r-f input jack. This results in a high-power r-f modulated klystron output. The output of the klystron consists of pulse-pairs, approximately 5.7 kw in peak power and 3.5 microseconds wide, which are fed to the control-duplexer.

(2) RADIO SET AN/GRN-9A AND AN/SRN-6. - As the transmitter portions of Radio Sets AN/GRN-9A and AN/SRN-6 are identical, all future references to Radio Set AN/GRN-9A in this section shall apply to both Radio Sets AN/GRN-9A and AN/SRN-6.

Because of the improved type of klystron employed in the power output stage of Radio Set AN/GRN-9A, the design of the transmitter section has been simplified, and the r-f power output has been increased to approximately 7.5 kw of peak r-f power. The SAL-89 klystron, used in Radio Set AN/GRN-9A, differs from the SAL-39A klystron, used in Radio Set AN/GRN-9, in two respects that enable an improvement in performance. First, the SAL-89 has a control grid that can be used to key the klystron beam current with a relatively low-powered pulse, thereby eliminating the need for a 12-kv beam pulse as required in Radio Set AN/GRN-9. Second, the overall operation of the SAL-89 is several times as efficient as the operation of SAL-39A, permitting the peak power output to be increased to 7.5 kw while the beam current drain on the high-voltage power supply has been reduced to approximately one-third of the beam current required by the SAL-39A.

Refer to figure 2-1.1, Radio Sets AN/GRN-9A and AN/SRN-6, Simplified Block Diagram of Amplifier-Modulator and Frequency Multiplier-Oscillator. The frequency multiplier-oscillator of Radio Set AN/GRN-9A employs the identical carrier frequency generating chain, and essentially the same video pulse generating circuits as used in Radio Set AN/GRN-9. Each pulse from the coder-indicator initiates the formation of a 3.5-μsec shaped pulse and a 10-μsec keying pulse. The 3.5-μsec shaped pulse is amplified in the video portion of the multiplier-oscillator to a power level sufficient to key-on and grid-modulate the klystron beam current. Square pulses of 10-μsec duration are applied to the cathodes of the keyed r-f amplifiers to key-on these stages that are normally cut off by a positive voltage applied to the cathodes. A sample of the 10-μsec pulse is fed from the frequency multiplier-oscillator to the receiver to be used as a blanking pulse as previously described.

The output of the keyed r-f amplifiers consists of a 10-μsec pulse of r-f energy which drives the klystron.

Coincident with the application of 10-μsec pulses to the klystron r-f input jack, the 3.5-μsec shaped pulse is applied to the klystron control grid. Klystron beam current, which is normally cut off by negative bias from the regulated bias supply in the amplifier-modulator, is keyed on and grid-modulated by the 3.5-μsec shaped pulse. As the beam current passes through the first resonant cavity of the klystron, it is velocity modulated by the application of the 10-μsec r-f pulse to the first caviiy of the klystron. The combined effect of the above-mentioned grid modulation and velocity modulation of the klystron beam current results in a high-powered r-f pulse having an envelope which is controlled in shape to insure that the radiated r-f power will occupy a minimum of spectrum about the assigned carrier frequency.

R-f output pulses from the klystron r-f output jack are fed through coaxial cable via a double slug tuner for impedance matching purposes to the control duplexer.

d. CONTROL DUPLEXER. - The control duplexer consists of a duplexer circuit that permits both the transmitter output signal and the receiver input signal to be fed through the same transmission line and antenna, and control circuits that permit the radio set to be operated by means of switches on the front panel of the control duplexer drawer. Also included in the control duplexer drawer are two resonant cavity filters inserted in series with the transmission line to improve the overall spectrum of the transmitter output.

Control duplexer circuits employed in Radio Sets AN/GRN-9, AN/GRN-9A, and AN/SRN-6 are identical except for the addition of a shorting strap between terminals 2 and 4 of TB1101 on the control duplexer employed in Radio Set AN/SRN-6.

e. ANTENNA GROUP. - The antenna group consists of the antenna, the antenna pedestal, and the antenna control. The magnetic variation subassembly, located in the coder-indicator, is part of the antenna bearing (azimuth) servo system. The antenna receives the interrogation pulses transmitted by the aircraft, and transmits the reply pulse-pairs, 15-cps and 135-cps reference bursts, and identification call. In addition the antenna supplies the 15-cycle and 135-cycle modulation imposed on the transmitted train of pulse-pairs. For a description of the antenna output pattern refer to paragraph 2 of Section 1.

The antenna control employs a bearing servo system that maintains the reference bursts and modulation in their proper relationship to magnetic north. Compensation for magnetic variation is set manually by a dial on the coder-indicator.

The antenna control incorporates a speed control system which maintains the induction motor in the antenna base driving the rotating cylinders of the antenna at a constant speed.

f. POWER SUPPLIES. - The power supplies provide regulated voltages at the various output levels required for radio set operation. These power supplies include low-, medium-, and high-voltage supplies for the transmitter, a coder-indicator power supply, and a receiver power supply.

g. POWER DISTRIBUTION AND CONTROL CIRCUITS. - The power distribution and control circuits function in such a way that the various components of the equipment are energized in their proper sequence, and the failure of one component will result in the de-energizing of other components that might be damaged by its failure. Safety interlocks on component drawers and compartments in which high voltages are present disconnect parts of the system when the drawers are pulled out or the compartments opened. The primary power supplied to Radio Sets AN/GRN-9 and Radio Set AN/GRN-9A is 208 volts ac, 60 cycles, three phase, four wire. Primary power supplied to Radio Set AN/SRN-6 is 440 volts ac, 60 cycles, three phase, three wire. Rectifiers in the various d-c power supplies throughout the radio set convert the a-c power supplied to d-c power of the required voltage. Additional a-c power is supplied from the 117-volt, a-c, for 120-volt a-c, single-phase, 60-cycle lighting circuit to the convenience outlets on the radio set and antenna base.

2. RADIO RECEIVER R-824/URN CIRCUIT ANALYSIS.

a. MIXER AND PREAMPLIFIERS. (See figures 2-2 and 2-3.) - The distance interrogation pulse-pairs pass through a low-pass filter (Z501), which rejects frequencies between 1,650 mc and 10,000 mc and passes on interrogations to the mixer stage of the receiver. A local oscillator signal from the frequency multiplier-oscillator in the transmitter is also applied to the mixer stage. At the mixer stage, the local oscillator signal, distance interrogations, and random noise pulses generated in the mixer itself are combined to produce an intermediate frequency signal of 63 mc. The output of the mixer stage, distance interrogation pulse-pairs having pulses spaced 12 μsec apart and random noise pulses at a random spacing, is fed to the preamplifiers. The mixer and the preamplifier function as follows; the signal received by the antenna is fed through low-pass coaxial filter Z501, the equivalent circuit of which is a series of filters which prevent unwanted signals from other pulse-producing equipment, operating in the band from 1,650 to 10,000 megacycles, from entering the system.

The output of Z501 is fed into one arm of the coaxial hybrid balanced "T" type mixer; oscillator power from the transmitter frequency multiplier-oscillator stage is fed into the other mixer arm. Essentially all power put into the mixer and local oscillator arms, therefore, is delivered to the two crystal mixers, CR201 and CR202. The balanced signal output of the mixer and random noise are fed, through impedance matching transformer T201, to the grid of V201.

To facilitate metering the current in the crystal mixers, position CR201 or CR202 of METER SELECTOR switch S501 connects the receiver panel meter to the appropriate crystal circuit. The low-pass filters in series with the meters prevent extraneous signals in the i-f pass band from entering the i-f amplifiers.

The output of the mixer is applied to the control grid (1) of first preamplifier stage V201 (figure 2-3). The slug tuned coil L206 in the plate circuit of V201 is tuned to 63 megacycles. The combination of L206, L209, L210, and L211 produces a relatively flat i-f response centered at 63 megacycles. The signal is amplified in stage V201 and applied to ground grid amplifier V202.

The signal is further amplified in stage V202. Bias voltage for stage V202 is supplied by R205 which is bypassed by C210; the combination of R205 with L205 and T201 forms the d-c grid return path for V202. Coupling between V202 and

V203 is provided by a "T" equivalent of a parallel-tuned transitionally coupled transformer. The slug tuned coils L209 and L210 are tuned to 63 megacycles. The signal is applied to the control grid of the final preamplifier, V203.

Stage V203 further amplifies the signal. The plate load for V203 is a parallel resonant circuit consisting of the tube's output capacitance, L211, L213, C221, and C220. A fraction of the output voltage is obtained across L213, C220, and C221 at a low impedance level to match the 50-ohm coaxial line to the following stage, the first i-f amplifier, V301.

b. I-F AMPLIFIERS. - The receiver i-f amplifiers, figure 2-4, increase the amplitude of the signal and noise received from the preamplifiers to a level sufficient to operate the Ferris discriminator. A negative bias (squitter control voltage) dependent on the number of interrogation and noise pulses out of the receiver is applied to the first and second i-f amplifiers, V301 and V302, controlling the gain of these stages and thereby controlling the number of noise pulses out of the receiver. Also, echo suppression circuits which allow operation of the equipment in the vicinity of large reflecting objects are employed in the i-f amplifiers.

The signal output of the preamplifier stages is applied to the control grid of i-f amplifier V301. The input circuit to the control grid of V301 consists of C304, L301, C302, L302, and the input capacitance of V301. L302 and the tube capacitance form a series resonant circuit which provides a step-up in voltage and impedance from the 50-ohm coaxial line. Because of the impedance matching afforded by the circuits at the input and output of the coaxial line, the i-f response is substantially independent of the cable length between the preamplifier and the i-f amplifier.

The i-f voltage is amplified in tubes V301 through V304. Inductances L303 through L306 are stagger-tuned, both to center the i-f response around 63 megacycles and to provide an i-f bandwidth of one megacycle.

A negative bias (squitter control voltage) of approxiamtely -5 volts under normal operating conditions is applied to the control grids of V301 and V302. The squitter control voltage is derived in circuits of the video amplifier chassis of the receiver and is dependent on the number of interrogation and noise pulses received by the receiver. The total number of pulses out of the receiver must be 2,700 pulses per second to sustain the sine-wave modulation-envelope on the transmitted r-f carrier. When the number of pulses, composed of distance interrogations and noise pulses, passing through the decoder, falls below 2,700

pulses per second, the squitter control voltage is made less negative and greater i-f amplification results. Therefore, the number of random noise pulses sufficiently amplified to pass through the coincidence decoder is increased to the point where the receiver output is 2,700 pulses per second. If the number of distance interrogations received is more than 2,700 pulses per second, the squitter control voltage is made more negative and the i-f gain is reduced to the point where the excess interrogations are not amplified sufficiently to pass through the coincidence decoder.

Echo suppression is obtained by means of RC discharge networks in the grid circuits of V302, V304, and V305. Thus, in the presence of large signals, networks C303 and R304, C320 and R315, C328 and R319 each develop sufficient bias voltage to reduce the i-f gain for a period proportional to the signal level input.

c. FERRIS DISCRIMINATOR. - The Ferris discriminator circuit, figure 2-5, consists of high and low "Q" 63-megacycle tuned input tank circuits, two detecting diodes, and r-f bypass and voltage divider loading network, two clamping diodes, and two triode amplifiers.

The Ferris discriminator circuit receives its input signal from the final i-f amplifier, V305. Its function is to detect the i-f signal and provide adjacent and near-adjacent channel rejection. The tank circuits are tapped at low impedance points; therefore, the tank circuits are relatively unaffected by differences in diode tube capacitance. In addition, the circuits are temperature-compensated to maintain frequency stability over the temperature range of from -54° C to +85° C (-65° F to +183° F). The circuit functions as follows:

Both tank circuits feeding V306 are tuned to 63 megacycles. Because of loading differences the "Q" of the tank circuit feeding V306B is reduced to approximately one-third the "Q" of the tank circuit feeding V306A. Because of the differences in the signal developed by each tank circuit and the voltage dividing connection to V306, V306-1 and its associated tank will pass only a negative going narrow band of frequencies centered at 63 megacycles. The characteristics of the V306-1 tank circuit are shown in figure 2-6A. V306B and its associated tank will pass a positive going wider band of frequencies also centered at 63 megacycles. The characteristics of the V306B are shown in figure 2-6B. The algebraic sum of the voltages at the input to the first triode amplifier is shown in figure 2-6C. With the sum bandwidth and negative signal passing characteristics of the Ferris discriminator as shown in figure 2-6C,

it can be seen that this circuit will only pass negative going pulses in a narrow band of frequencies centered at 63 megacycles.

The output of the detecting diodes is coupled through capacitor C362 to the control grid of V307 and plate of V308A. If the incoming pulses are negative going pulses, V308A will remain inoperative and the signal will be amplified by V307A and passed on to V307B. If the incoming pulses are positive going pulses, V308A will go into conduction, shorting grid control resistor R329 and passing the positive pulses to ground. The positive portion of the signal is further rejected in stages V307B and V308B, which act in a similar manner to V307A and V308A, taking into account the 180° phase inversion that took place in V307A.

The signal is then applied through P302 and J402 to the first video amplifier V402A in the video amplifier chassis.

d. VIDEO AMPLIFIERS. - The video signal and noise pulses from the i-f chassis are routed through J402 to the control grid (2) of the first video amplifier, V402A. Refer to figure 2-7. The video signal is amplified and passed through coupling capacitor C401 to the control grid (1) of the blanking gate tube, V401.

The output of the final i-f amplifier, which is the input of the first video amplifier, can be checked at TP5 (J409) and at J503.

The gate-blanked video amplifier amplifies the signal and feeds it through coupling capacitor C402 to the control grid (7) of the final video amplifier, V402B.

However, after every pulse-pair is decoded, a negative 40-microsecond blanking pulse from the blanking gate amplifier is applied to the suppressor grid of V401. This blanks out V401 and prevents pulses from passing through it. V401 is also blanked out by a positive blanking pulse to its cathode circuit from the transmitter whenever the klystron is keyed on.

The final video amplifier, V402B, further amplifies the signal, which is then fed to a coincidence-type decoder tube (V403) through coupling capacitor C403 directly to the suppressor grid (7) and through a 12-microsecond delay line, DL401, to the control grid (1).

e. COINCIDENCE DECODER. - Coincidence decoder, figure 2-8, tube V403, is a semiremote cutoff pentode biased to cutoff by a positive voltage applied to its cathode. As used in this circuit, conduction of V403 requires a simultaneous positive voltage on both the control grid (1) and suppressor grid (7). The circuit

functions in the following manner: each pulse from V402B is applied first to the suppressor grid of V403 and then through a 12-μsec delay line to the control grid of V403.

When a pair of interrogation pulses or random noise pulses separated by 12 microseconds arrive at the decoder, the first pulse, delayed by 12 μsec, arrives at the control grid coincidentally with the arrival of the second pulse at the suppressor grid. The decoder conducts when the second pulse of a pulse-pair is on the suppressor grid, and the first pulse is on the control grid. This characteristic insures the decoding only of pulses (noise or interrogations) separated by 12 microseconds. It should be noted, however, that since the decoder is biased to cutoff, the pulse input must be of sufficient strength to cause conduction. This means that not all 12-μsec spaced noise or interrogation pulse-pairs will be decoded, but only those above a minimum value. The number of pulses above this value is controlled by varying the i-f gain with the squitter control voltage. The receiver is designed to maintain this number rate at 2,700 ±90 pulses per second. The decoder output consists of a single pulse for each decoded pulse pair. These pulses trigger one-shot multivibrator V404.

f. ONE-SHOT MULTIVIBRATOR. - One-shot multivibrator V404, figure 2-9, is triggered once for each pulse received from the decoder tube. The pulses out of the one-shot multivibrator are all of equal amplitude and width. Stage V404 output is routed to three different stages. The plate (4) output of V404 is fed to V406, the blanking one-shot multivibrator. The cathode (2) output is routed to two different stages, one output to pulse amplifier V408 (squitter voltage generator stage); the other output to cathode follower V405 (receiver output to the coder-indicator).

g. BLANKING GATE GENERATOR. (Refer to figure 2-10.) - The blanking gate one-shot multivibrator, V406, is triggered by one output of the multivibrator, V404. Tube V406 supplies a 40-microsecond blanking pulse for each pulse received from V404. The blanking time adjustment potentiometer R443 controls the blanking time from 20 to 65 microseconds by changing the time constant of the multivibrator RC network. Equipments as delivered have the blanking time preadjusted at 40 microseconds. The 40-microsecond pulse output is fed to blanking gate amplifier V407B.

The blanking gate amplifier, V407B, is heavily biased by the application of a fixed negative pulse on its grid; conduction takes place only on strong positive

pulse signals. Because of the 180° phase inversion in the tube, a negative output pulse of 40-microsecond duration is produced. This pulse is applied to the suppressor grid of gating tube V401, causing cutoff in the tube for 40 microseconds. Therefore, a receiver output with a minimum of 65-microsecond spacing between pulses is accomplished.

h. SQUITTER VOLTAGE GENERATOR. - The second output of V404 feeds pulse amplifier V408 (see figure 2-11). Grid limiting is used in this stage to keep its output substantially independent of the amplitude of the input pulses. The output of V408 is fed by transformer T401 to the pulse stretcher and counter diode V409B.

The long time constants of the RC networks in the plate circuit of pulse stretcher diode V409B make the voltage on the grid of V407A essentially dc. The cathode of V407A is connected through R426 to the -105-volt source. When the bias voltage on the grid of V407A is the correct value to effect a squitter rate 2,700 ±90 pulse-pairs per second, the voltage on the cathode, because of the drop across R426, is approximately -5 volts with respect to ground under closed loop conditions. This voltage, which is the squitter control voltage, is applied to the grids of i-f amplifiers V301 and V302 and controls the i-f amplifier gain. If the receiver pulse output tends to fall below 2,700 ±90 pulses per second, the number of pulses fed to the pulse amplifier, V408, also decreases. This results in a lower d-c output from the pulse stretcher diode, V409B, and a less negative bias on the grid of V407A. Increased current flow in this stage results in a greater voltage drop across R426 and consequently a less negative voltage at the cathode of V407A with respect to ground. This reduced squitter control voltage to the i-f amplifiers results in general increase in the level of signal reaching the decoder. Therefore, a greater number of decodable pulses attain sufficient amplitude to operate the decoder and bring the receiver output back up to 2,700 ±90 pulses per second. If the pulse output tends to rise above 2,700 ±90 pulses per second, the circuit operates in the opposite manner, that is, to increase the negative squitter control voltage to the i-f amplifiers. Potentiometer R427 is used for squitter voltage adjustment.

Since without the application of a negative bias to the grid of V407A, the voltage drop across R426 may result in a high positive voltage (in excess of +20 volts) being applied to the i-f amplifiers and, consequently, a complete blocking of the receiver: diode V409A is used as a d-c clamp which prevents

the voltage from rising above +5 volts while the receiver is warming up. As soon as pulses are decoded, the applied bias to V407A reduces the voltage drop across R426 and the squitter control voltage becomes negative. V409A then has no effect.

i. RECEIVER OUTPUT CATHODE FOLLOWERS. - The third output of V404 is to cathode follower stage V405 (see figure 2-9). V405 is a double triode. One triode output is not used at this time. The output of V405, decoded distance interrogations and random noise pulses at a 2,700 ±90 pulses per second rate with a minimum of 52-microsecond spacing between pulses is the receiver output. It is fed through J404 to the input of the coder-indicator. The pulses are at an amplitude of +20 volts and are of four-microsecond duration. This output can be checked at J411. An output is also brought out to the front panel of the receiver through J507. Receiver output can be checked on the front panel TEST OUTPUT.

3. CODER-INDICATOR KY-235/URN CIRCUIT ANALYSIS.

a. 135-CPS REFERENCE BURST GENERATOR. - This stage consists of tubes V601A, V609, and V610. Figure 2-12 illustrates the 135-cps reference generator. Pulse amplifier V601A receives the trigger pulse from the 135-cps pulsing coil of the antenna system. Since its cathode is grounded, bias to V601A is zero. The trigger pulses from the antenna contain both positive and negative excusions, the polarity being chosen so that the positive occurs first. When fed into V601A the positive excursion is clipped; grid current produces a voltage drop across R658, reducing the net signal at the grid nearly to zero. When the trigger pulse from the antenna is negative, a sharp change in plate current occurs. This sharp change in plate voltage triggers multivibrator V609, which functions as a 135-cps gate. Stage V609 is a one-shot keying multivibrator, which, because of the circuit constants used, has a natural period longer than the time required for the generation of six pulses by the 41.7-kc pulsed oscillator. When V609 is in a stable condition, V609B is conducting owing to B+ applied to the grid through R663. Because of the cathode bias developed across R665, V601A is cut off. When a positive pulse is applied to the grid of tiode V601A, its plate current flows, producing a negative pulse which is coupled to grid pin 2 cutting off the plate current in V609B. This causes a positive pulse to be developed on the plate of V609B and a negative pulse to be developed on the cathode. The positive pulse is fed to priority gate blocked amplifier V611 as a blocking gate, and the negative pulse is used

to key the 41.7-kc oscillator, V610. Pulses which originate in keyed oscillator V610 are fed back from the output of V605 after passing through shaping and amplitude setting circuits to the grid of V609A, where they appear as small negative spikes (see figure 2-13). The natural period of multivibrator V609 is determined by the time constant of the RC circuit, R663 and C625. Once section V609B is cut off, it remains cut off until capacitor C625 charges from the B+ supply through R663. The feedback pulses originating in the pulsed oscillator ride on the charging curve of capacitor C625 as illustrated in figure 2-13. Potentiometer R672 provides a means of adjusting the amplitude of the feedback pulses so that the sixth pulse will start V609B conducting and cut the 135-cps keying gate pulse off at 132 microseconds. The spacing between the 135-cps reference burst pulses is 24 microseconds.

The negative keying gate from the cathode of V609B is applied to the grid of pulsed oscillator tube V610A, cutting off this section of the oscillator tube. When V610A is cut off, ringing circuit C626, C650, and L602 is shock excited to produce a sine wave at a frequency of 41.7 kc to which the ringing circuit is tuned. The signal from the ringing circuit is passed through V610B where power amplification takes place. Capacitors C626 and C650 are tapped to function as a voltage divider. Although the voltage gain through a cathode follower is always less than one and voltage is dropped because of tapped capacitor division, sufficient feedback voltage from the cathode is provided to the grid circuit to replace tank circuit losses and sustain oscillation. Any greater feedback would drive the tube to cutoff and yield a clipped output. When the negative gate on the grid of V610A ends, V610A conducts and acts as a low resistance circuit which heavily damps the ringing circuit, terminating oscillation. The pulsed oscillator remains in a nonoscillating condition until the next negative keying gate is impressed on the grid of V610A, cutting off plate current, and repeating the cycle as previously described.

The 135-cps reference burst pulses from the 41.7-kc keyed oscillator are shaped and amplified in V604A, the reference burst amplifier. The output of V604A is coupled to one-shot multivibrator V605.

b. 15-CPS REFERENCE BURST GENERATOR. - The operation of this circuit consisting of V601B, V602, and V603 is similar to that of the 135-cps reference burst generator. However, a 33.3-kc keyed oscillator is employed and the output consists of 12 pulses spaced 30 microseconds apart. Like the 135-cps reference burst generator, the 15-cps reference burst generator sends blocking

pulses to the priority gate blocked amplifier and passes its output through reference burst amplifier V604A to one-shot multivibrator V605.

c. SHAPING AMPLIFIERS. - This stage consists of one-shot multivibrator V605 and triggered blocking oscillator V606 (see figure 2-14). V605 is a one-shot multivibrator which receives signal pulses from priority gate blocked amplifier V611 and reference bursts from amplifier V604A. Triggering signal pulses to the multivibrator will vary in amplitude and waveshape, while output pulses will be of uniform amplitude and waveshape. The time spacing of multivibrator output pulses will be an exact duplicate of the trigger pulses. In the stable condition of the multivibrator, V605B is conducting because of a positive bias applied to grid pin 7 through resistor R623. Plate current through R625 produces a positive voltage on the cathode of triode V605A, which biases this half of V605 to cutoff. When a positive trigger is applied to grid pin 2, triode V605A conducts and passes a negative pulse to grid pin 7 which cuts off triode V605B. Multivibrator V605 is then in the unstable condition until C611 discharges through R623, causing grid pin 7 to go positive. Multivibrator V605 then returns to the stable condition, with triode V605B conducting and triode V605A cutoff. The time required for the multivibrator to go through one complete cycle is determined by the time constant of RC circuit R623 and C611. Multivibrator V605 is triggered by positive pulses generated in the 135-cps and 15-cps reference burst generators applied to grid pin 2, and by negative pulses from priority gate blocked amplifier V611 applied to grid pin 7. Negative pulses are taken from plate pin 1 of V605A and shaped by network C630, R674, R675, and R676 to provide sharp negative spikes for timing the 135-cps reference burst generator as explained previously. The negative pulses from priority tube V611 may pass to the input of V602 but have no effect on the multivibrator because triode V602A is already biased to cutoff during the time priority tube V611 is passing pulses.

Sharp positive pulses from multivibrator V605 excite triggered blocking oscillator V606. In its quiescent stage both sides of V606 are cut off by bias applied to both grids through voltage divider R632, R633, and R634 (approximately -17 volts on V606A and -37 volts on V606B). A sharp positive pulse on the grid of triode V606A will cause a pulse of plate current to flow through the primary of transformer T602. While the plate current is increasing from zero in the primary of T602, the secondary of T602 develops a positive voltage on the grid of triode V606B which causes plate current to flow through triode V606B

and the primary of T602. The increase in current in the primary of T602 causes a further increase in positive voltage through T602 to be applied to the grid of V606B. This action continues until the plate current of triode V606B has reached saturation and no further increase in plate current is possible. Since a positive feedback voltage is induced on the grid only while current through the primary of T602 is increasing, the grid now swings back in the negative direction toward its original voltage, thereby reducing plate current through triode V606B. Current through T602 is now changing in a direction which will induce a negative voltage on the grid of V606B.

This action continues until triode V606B is biased to cutoff. Resistors R627 and R629 across T602 produce a damping effect which allows the oscillator to operate effectively for only one cycle on application of trigger pulses. Triode V606A is not actually a part of the oscillator, but primarily acts as a trigger which converts sharp pulses of voltage from V605 into sharp pulses of current in T602.

d. ENCODING DELAY LINE. (Refer to figure 2-15.) - Choke L604 and capacitor C614 filter out reflections from the input circuit delay line DL601. The output pulses of V606 are coupled to delay line DL601 through transformer T603. Transformer T603 functions as an autotransformer, matching the input impedance of delay line DL601, and delivering a signal of approximately 560 volts peak to peak to the input of the encoding delay line.

Pulses having an amplitude of approximately 20 volts peak to peak are tapped from encoding delay line DL601 after 32 microseconds delay and after 44 microseconds delay. For each pulse into encoding delay line DL601 two positive pulses spaced 12 microseconds apart are delivered to the grid of pulse amplifier V607A.

e. OUTPUT AMPLIFIERS. - These circuits include V607A, V615, and V607B (see figure 2-16). Pulse amplifier V607A inverts and amplifies the doubled pulses from delay line DL601.

The negative pulse output of pulse amplifier V607A is applied to one-shot multivibrator stage V615. The output of V615 is 15-microsecond pulses. Multivibrator stage V615 delivers to stage V607B one pulse for each pulse it receives. In the quiescent stage, because of the positive bias applied to the cathode of the V615B half of the multivibrator, V615B is cut off and V615A is conducting.

The application of negative pulses from V607A to the control grid (2) of V615A drives V615A into cutoff. Its rise in plate voltage is transferred to

grid 7 of V615B and drives that half of the multivibrator into conduction. The period of conduction of V615B is 1.5 microseconds as determined by the RC time constant of C621 and R639. V615A then goes into conduction cutting off V615B. The multivibrator will remain in the above condition until the application of the next negative input pulse.

Cathode follower stage V607B receives the uniform positive output pulse of V615. The positive input pulse to stage V607B causes the stage to conduct. The output of stage V607B is taken off cathode resistors R649 and R650. The output of V607B, consisting of the north reference burst, auxiliary reference burst, identification time, distance interrogations and random noise pulses, is fed through J602 and P407 to the transmitter. The output pulses of V607B which are the output of the coder-indicator are pulses 12 microseconds apart, and 1.5 microseconds wide. The cathode follower, V607B, serves to isolate the multivibrator, V615, and to match the output to the 50-ohm load to the transmitter.

A portion of the output of V607B, taken off resistor R650, is delivered to test jack J607 on the front panel of the coder-indicator, labeled TEST OUTPUT, and enables the operation to examine the output of the unit.

f. IDENTIFICATION CALL MECHANICAL KEYER. - The motor-driven code keying wheel controls the selection of either distance reply or identification tone pulses as input signals to V611, the priority gate blocked amplifier (see figure 2-17).

The keying wheel, in conjunction with the code start timing cam, functions to initiate a beacon identification coded call every 37.5 seconds.

The keying wheel revolves at a speed of eight rpm. Sections of the wheel are set farther from its center to indicate selection of a dot or dash. Each set section causes the keying switch S607 connection to the B- voltage divider to open.

The B- voltage divider produces, by the action of R791 and R686, a gate potential of -50 volts whenever it is not grounded through the identification call mechanical keyer.

The keying switch removes the ground connection from the B- voltage divider to initiate a dot or dash tone pulse.

When the B- voltage divider is grounded, distance reply pulses are selected as the input to the priority gate amplifier.

The code start timing switch, S604, is controlled by a cam which revolves at 1.6 rpm. This single-pole, double-throw timing switch grounds either the B- voltage divider or one side of the keying switch. The timing switch control cam is designed so that the timing switch will ground one side of the keying switch for one revolution in every five of the code keying wheel.

With one side of the keying switch connected to ground through the timing switch, the mechanical action of the keying switch may control the application of ground potential (0 volt) to the B- voltage divider.

Both the keying switch and the timing switch connections from the B- voltage divider to ground must be open simultaneously to produce a code tone pulse. Therefore, no code tone pulses are possible during the time the timing switch applies ground potential to the B- voltage divider. This condition exists for the four revolutions of the keying wheel directly following each cycle initiating a beacon identification call.

Resistor R687 and capacitor C637 form a filter circuit that suppresses extraneous pulses generated by the make and break of keying contacts in the mechanical keyer.

From the above explanation it is evident that the identification call keying wheel alternately keys the distance reply pulses and identification call tone, permitting only one of these two signals to reach the grid of priority gate blocking amplifier V611 at any one time.

g. GATE BLOCKED DISTANCE REPLY AMPLIFIER. - The application of either ground potential or -50 volts from the B- voltage divider controls the operation of V604B, the gate blocked distance reply amplifier. See figure 2-17. When the grid resistor for V604B is returned to -50 volts, the tube is biased far beyond cutoff and therefore blocks passage of the distance reply pulses. When the action of S607 or S604 returns the grid resistor to ground, V604B functions as a cathode follower and passes distance reply output pulses to priority gate blocked amplifier V611.

h. KEYED 1,350-CPS TONE GENERATOR. - This circuit consists of V612, V613A, V614, V613B and CR603 (see figure 2-18).

The identification call tone of 1,350 cps is generated by oscillator V612. Coil L603 is adjusted to provide the proper inductance for oscillation at 1,350 cps. A positive synchronizing 135-cps pulse from the 135-cps reference burst generator is applied to triode V612A. The plate load circuit for this tube consists of C652 and C653 and L603 which form a parallel resonant circuit tuned to 1,350

cps, i.e., the tenth harmonic of the 135-cps pulse. The same LC combination also serves as the tank circuit for a Hartley oscillator using V612B. The output of the oscillator appears across R692 and R693 is coupled to V613A.

Stage V613A amplifies and shapes the tone signal so that it can be used as a trigger for multivibrator V614. Potentiometer R798, which in conjunction with R797 and C643, determines the period of one-shot multivibrator V614, is adjusted to provide a period of 100 microseconds. An output pulse is taken off each plate of the multivibrator, mixed, and differentiated to produce sharp negative pulse-pairs on the grid of the identification call keyer tube, V613B.

The manner in which two sharp negative pulses are obtained from each cycle of multivibrator V614 is shown in figure 2-19. Waveform (1) shows the voltage changes on plate pin 6 of triode V614A as the multivibrator goes through two complete cycles, due to the application of two trigger pulses. In the quiescent state of the multivibrator, triode V614A is cut off, and plate voltage is at +250 volts, the full B+ supply voltage. At the instant a trigger pulse is applied, plate voltage at pin 6 takes a sharp negative swing. This sharp negative change is passed through C645 as a negative spike as shown in figure 2-19, waveform (2). At the end of the period of multivibrator V614 the plate voltage on pin 6 changes in a positive direction until it is back to +250 volts. Since the change in the positive direction is relatively slow, a small positive pulse is passed through C645 to the grid of triode V613B as shown by waveform (2). Waveform (3) shows the change in plate voltage of triode V614B, which is pulsed in the positive direction during the period of multivibrator V614. A positive pulse is derived through C644 during the rise in plate voltage, and a negative pulse is derived through C644 during the fall in plate voltage. Since the change in the negative direction is very sharp as compared to the change in the positive direction, the negative pulse will be much larger than the positive pulse, as shown by waveform (4). Waveform (5) shows the signal present on grid pin 7 of triode V613B because of the addition of waveforms (2) and (4). Each pair of pulses is separated by 740 microseconds, with the pulses in each pair separated by 100 microseconds. In this manner, a constant duty cycle of 2,700 pulses per second is maintained while the tone frequency of 1,350 cps is preserved in the form of pulse-pairs. Clamping diode CR603 allows to pass or grounds out the identification call tone signals depending on the position of the identification call mechanical keyer. When the microswitches in the mechanical keyer assembly are closed, ground is applied

to the plate of diode CR603 through resistor R687. With the plate grounded, diode CR603 becomes a low impedance path to ground for negative pulses sent to the grid of V613B. Therefore, the tone signal is grounded out through the diode and no tone signal pulses will appear at the grid of V613B. When the keying wheel assembly removes ground from R687, a negative bias of approximately -50 volts from voltage divider R791 and R686 is applied to the plate of diode CR603. With -50 volts on the plate, diode CR603 will not pass the negative tone signal pulses. Under these conditions, keyer tube V613B will receive and pass the 1,350-cps pulse pairs to the priority gate blocked amplifier, V611.

i. PRIORITY GATE BLOCKED AMPLIFIER. (Refer to figure 2-20.) - With neither reference burst gates, identification call pulses, nor distance reply pulses present at V611, V611A will have approximately zero bias and V611B will be at cutoff with -10 volts applied to its grid from voltage divider R682 and R651. If only distance reply or identification call pulses appear at V611B, the positive input signals override grid bias, are amplified, and passed on to trigger multivibrator V605. However, whenever reference burst pulses are being generated a positive gate from the working reference burst generator causes V611A to conduct heavily. This causes a large voltage drop across R681 which acts as a cathode bias resistor for V611.

This cathode bias, in combination with its fixed -10-volt grid bias, drives V611B so far into cutoff that the positive identification call or distance reply pulses on its grid can no longer override the cutoff bias. These signals are now blocked. Therefore, the priority of the reference burst pulses over the identification call and distance reply pulses is established.

The signals permitted to pass through the priority gate blocked amplifier are coupled to the output amplifier circuits at V605. These signals are then shaped, double encoded, amplified, and sent to the transmitter as components of a multiplexed signal as described previously for the reference burst signals.

j. ANTENNA SYNCHRONIZATION 1,350-CPS OSCILLATOR. - The frequency of this oscillator circuit is controlled by tuning fork Y601 (see figure 2-21). The 1,350-cps output of the tuning fork output coil is applied to the grid of V608A. Part of the V608A output is used as a 1,350-cps reference to check the rotation speed of the antenna. This voltage is coupled to V608B which acts as a cathode follower with the input coil of the tuning fork as its cathode load. In this manner, sufficient voltage generated within the oscillator circuit is fed back to the tuning fork to sustain oscillation.

4. FREQUENCY MULTIPLIER-OSCILLATOR CV-590/GRN-9 CIRCUIT ANALYSIS.

Note

Frequency Multiplier-Oscillator CV-590/GRN-9 is used in Radio Set AN/GRN-9 only.

a. CARRIER GENERATING CHAIN. - The carrier generating chain, located on the r-f chassis, contains a crystal oscillator circuit which originates the radio frequency from which the transmitter carrier frequency and receiver local oscillator frequencies are derived. The oscillator circuit is a Butler or Navy type crystal oscillator and frequency doubler stage, which has an oscillator frequency output of between 40.083333 megacycles to 42.666667 megacycles for the low band and from 47.958333 megacycles to 50.541667 megacycles for the high-band frequencies. The high- and low-band circuits are identical except for several tuning components which have slightly different values to compensate for the difference in the frequency range to which they must tune. The following discussion will refer only to the high-band circuit components. The frequency output of the circuits following will be for channel 113, a typical high-band channel. The frequency output from the oscillator portion of the circuit is 50.000000 megacycles and from the doubler the output is 100 megacycles.

An oscillator is basically an amplifier with a positive feedback path. Tube V1501 is a double triode connected as two separate amplifiers. V1501A is a grounded grid amplifier. Its input is the crystal frequency developed across R1502. The plate circuit of V1501A is tuned to the oscillator frequency (50 mc); tuning is accomplished by adjustment of L1502. The oscillator frequency is coupled through capacitor C1504 to the control grid pin 7 of V1501B. Tube V1501B is a harmonic generator paraphase amplifier. The cathode follower output of V1501B developed across R1503 provides regenerative feedback to the grounded grid amplifier V1501A as necessary to sustain oscillations. The frequency at which feedback takes place is established by the crystal Y1501. The feedback path, through the crystal, is a low impedance path only at oscillator frequency.

The plate of V1501B is tuned to the second harmonic of the oscillator frequency (100 mc). Tuning is accomplished by adjustment of L1503. The output is coupled through capacitor C1505 to the second doubler stage V1502.

Coil L1501 is an r-f choke, capacitors C1502 and C1503 are r-f bypass capacitors. Resistor R1501 is a decoupling resistor for V1501A. The combination of C1506 and L1504 insures that oscillator frequency stability is maintained by cancelling the capacitive component of the crystal circuit impedance. Resistors R1504 and R1505 are grid leak resistors. A portion of the oscillator (V1501A) output voltage is fed from R1505 through choke L1528 to TB1501 for checking oscillator output. A series L-C circuit located in the crystal oven serves to hold the frequency produced by the crystal to within ±0.002 percent.

CAUTION

> Adjustment of the crystal oven circuit is not a tuning or field adjustment. Adjustment should not be attempted without the proper test equipment, and only when found to be absolutely necessary.

The output of the oscillator first doubler stage, V1501, a frequency of 100 megacycles, is fed to the control grid pin 1 of the second doubler stage, V1502. Triode V1502 is tuned to the second harmonic of the input frequency. Tuning is accomplished by adjusting coil L1509. The frequency output of second doubler stage V1502 is of 200 megacycles, and is fed to the third doubler stage V1503.

Resistors R1507 and R1508 are grid leak resistors. A voltage is taken off R1508 and fed through choke coil L1530 to terminal board V1501 for checking the first doubler output voltage. Capacitors C1512 and C1513 are cathode bypass capacitors. R1510 is the cathode resistor, C1514 is a coupling capacitor, C1515 is a screen grid bypass capacitor. Coil L1508 effectively isolates the plate from the screen while providing a d-c B+ path for both. Coil L1509 and C1516 form a series resonant circuit which is tuned to the second harmonic of the input frequencyof second doubler stage V1502.

The output of the second doubler stage, V1502, a frequency of 200 megacycles, is applied to the cathode of grounded grid amplifier V1503. The output of V1503 is coupled through Z1507 to the cathode of the tripler stage, V1504. This circuit is tuned to the second harmonic of its input frequency by capacitors C1519 and C1522. The frequency output of this stage, the third doubler stage, is of 400 megacycles. Coils L1510 and L1511 are r-f chokes. Capacitors C1520 and C1521 are r-f bypass capacitors. Resistors R1511 and R1513 are cathode resistors. A voltage is taken off R1513, passes through choke coil L1529, and is fed to terminal 13 of J1509 for checking the second doubler

output voltage. Capacitors C1518 and C1558 are coupling capacitors. The series resonant tuned output circuit is composed of capacitor C1519, stub Z1507, and capacitor C1522.

The output of the third doubler V1503, a frequency of 400 megacycles, is fed to tripler stage V1504, which produces an output of 1,200 megacycles. The tripler stage, V1504, employs a 2C39A lighthouse tube in conjunction with a broad band coaxial type of resonant circuit.

The third doubler output is fed to the cathode circuit of V1504, is amplified, and appears with a large third harmonic content in the plate circuit. A coaxial line type cavity is connected between the plate and grid of this circuit. The cavity is tuned by means of tuning screws. As the screws are tuned, the capacity applied across the cavity is varied, changing the resonant frequency of the grid plate circuit.

The tripler signal is picked up by loops connected to the grid line. The tripler stage V1504 has two outputs. One output is fed to the mixer stage of the receiver to be used as the receiver local oscillator signal. The second output is to the cathode of first r-f amplifier V1505.

Physically, the grid plate cavity of tripler stage V1504 consists of a concentric line. The shell, and the anode cap which is capacity coupled to it, form the outer conductor. The grid line forms the inner conductor. A screw-mounted tuning ring fits into the cavity shell. As the screw is turned the capacity applied across the cavity is varied, which changes the resonant frequency of the grid plate circuit.

Filament voltage is applied to V1504 at X and XI. L1531 and L1532 are r-f chokes, C1546 and C1547 are r-f bypass capacitors effectively placing the heater at zero r-f potential.

The output of this final multiplier stage is coupled to the first r-f amplifier stage, V1505.

b. SHAPED PULSE GENERATOR. - Positive pulses from the coder-indicator video chassis are applied to jack J1401 on the frequency multiplier-oscillator video chassis. Pulses at the output of the coder-indicator are 1.5 microseconds wide which is a considerable portion of the period of multivibrator V1402. To prevent the negative going trailing edge of the trigger pulse from affecting the operation of multivibrator V1402, crystal diode CR1402 is inserted in series with the signal path of the trigger pulse. The positive going leading edge of the trigger pulse is passed through CR1402 and triggers multivibrator V1402.

Multivibrator V1402 is a monostable multivibrator with triode V1402B conducting during the quiescent state. The grid of V1402B is returned to the 250-volt B supply through resistors R1403 and R1466. The grid of V1402A is connected to a voltage divider consisting of R1468, R1446, R1469, and R1407 connected between the +250-volt and -375-volt power supplies. With V1402B conducting, plate current flowing through R1468 and R1446 causes a drop in voltage at the plate of V1402B and changes the voltage distribution in the voltage divider so that approximately -30 volts is applied to the grid of V1402A. Triode V1402A is held at cutoff until a positive trigger pulse is applied to its grid. A positive pulse on the grid of V1402A causes a negative pulse to be developed at the plate which is coupled through C1423 to the grid of V1402B. As the grid of V1402B swings negative, the plate voltage rises and a positive signal is coupled through C1421 back to the grid of V1402A. The positive signal fed back to the grid of V1402A continues the action started by the trigger pulse until V1402B is cut off. Triode V1402B remains cut off until C1423 discharges through R1466 and R1403. When plate current starts to flow in V1402B the multivibrator returns to its stable condition with V1402A cut off and V1402B conducting heavily. The time constant of the RC circuit consisting of capacitor C1423 and resistors R1403 and R1466 determines the width of the pulse generated in multivibrator V1402. Potentiometer R1466 is adjusted to provide a 2.5-microsecond square pulse at the output of V1402B.

Power amplifier pentodes V1403, V1404, and V1405 are operated in parallel in order to obtain the high-powered pulse required to drive subsequent shaping circuits. Grid resistors R1410, R1413, and R1414, and plate networks Z1401, Z1402, and Z1403 are parasitic suppressors. Grid resistor R1408 is common to all three tubes, and is returned to the -375-volt supply to obtain grid bias sufficient to cut off the power amplifiers in the absence of a signal on the grid. Pulse transformer T1402 is the common plate load for the power amplifiers and provides impedance matching and phase inversion between the output of the power amplifiers and the input of the shaping network. When a positive pulse from V1402 is applied to the grids of power amplifiers V1403, V1404, and V1405, plate current flows through the power amplifiers and pulse transformer T1402, causing a negative rectangular pulse, 2.5 microseconds wide and approximately 800 volts in amplitude, to be impressed across the primary of T1402. A positive pulse approximately 1,350 volts in amplitude is induced in the secondary of T1402 and is applied to the shaping network through series diode V1406. Resistor R1416 loads the secondary of T1402 damping out ringing due

to the sudden collapse of the inductive field in T1402 when plate current in the power amplifiers is cut off. Series diode V1406 passes the positive 2.5-microsecond pulse to the shaping network while preventing negative transients in the secondary of T1402 from being passed to the shaping network. Capacitors C1406, C1407, C1408, and C1417, and coils L1401, L1402, and L1403 form a low-pass filter. which is used as the 3.5-microsecond pulse-shaping network. Rectangular pulses 2.5 microseconds wide at the input of the shaping network are reduced in amplitude and shaped into pulses 3.5 microseconds wide having a gradual rise and decay time. Control of the pulse shape at this point insures that a minimum of r-f spectrum will be occupied by the final transmitted r-f output pulse. Resistors R1417 and R1418 provide the proper termination for the shaping network. Potentiometer R1417 provides a means of adjusting the terminating impedance to match the characteristic impedance of the shaping network, thereby preventing reflection in the shaping network and distortion of the pulse.

Positive pulses from the shaping network are coupled through capacitor C1410 and parasitic resistor R1422 to the grid of cathode follower V1407. Potentiometer R1470 is adjusted to provide the maximum signal on the grid of cathode follower V1407 which will not overdrive the grid and cause limiting of the shaped pulse. In the absence of a pulse, V1407 is biased very close to cut off by negative voltage from the voltage divider consisting of potentiometer R1420 and grid resistor R1421. Potentiometer R1420 is adjusted to limit the plate current through V1470 to 2 milliamperes.

The output of cathode follower V1407, which is a specially shaped video pulse approximately 800 volts in amplitude and 3.5 microseconds wide, is fed through P1503 to the plates of the keyed r-f amplifiers, V1505 and V1506, on the r-f chassis. Amplifiers V1505 and V1506 are keyed on and plate-modulated by the 3.5-microsecond shaped pulse.

A sample of the 3.5-microsecond shaped pulse is tapped off the cathode resistance of V1409 and fed to the SHAPED PULSE jack (J1405) on the front panel of the frequency multiplier-oscillator.

c. KEYED R-F AMPLIFIERS. - Stages V1505 and V1506 are r-f amplifiers operated in cascade employing 2C39A lighthouse tubed in conjunction with a broadband coaxial type resonant circuit. The operation of V1505 and V1506 is similar to tripler stage V1504, the only difference being that V1505 and V1506 are keyed. The output from stage V1407, shaped 3.5-microsecond wide pulses

(azimuth reference burst, identification tone pulses, distance interrogation and random noise pulses), is used to key and plate-modulate the r-f signal from tripler stage V1504 in the r-f amplifier stages V1505 and V1506. The pulsed r-f output, coupled to the klystron input cavity through J1503, provides up to 100 watts peak drive power to the klystron.

The lighthouse tube cavities are tuned by means of tuning screws (maximum output at resonance). Capacitors C1548, C1549, C1550 and C1551 are r-f bypass capacitors effectively placing the heater at zero r-f potential. Filament voltage is applied to V1505 and V1506 at Y and Y1, and Z and Z1.

d. VOLTAGE REGULATOR STAGE V1401. - Tube V1401 is used as a voltage regulator to provide 150 volts B+ for the oscillator and doubler stages in the frequency multiplier-oscillator r-f chassis.

e. GATE PULSE GENERATOR. - Pulses from the coder-indicator, in addition to triggering the shaped pulse generator as previously described, are fed through delay line DL1401 and coupling capacitor C1413 to control grid pin 2 of one shot multivibrator V1408 (see figure 2-24). Delay line DL1401 delays the formation of the klystron gate pulse sufficiently to center the shaped 3.5-microsecond pulse on the 10-microsecond gate pulse at the klystron input. This is accomplished by taps on DL1401 which vary the start of the 10-microsecond wide gate pulse. Maximum delay of DL1401 is 1.4 microseconds.

Vacuum tubes V1401 and V1408 form a one-shot multivibrator stage which is similar in operation to one-shot multivibrator V1402 described under paragraph b, "Shaped Pulse Generator", the principal difference being that the gate pulse generating multivibrator has a longer period in order to produce a 10-microsecond output pulse. The RC circuit consisting of C1416 and resistors R1402 and R1465 determines the period of the one-shot multivibrator, with R1465 being adjusted to set the output pulse width at 10 microseconds. Both sections of the one-shot multivibrator consist of twin triodes connected in parallel to insure conservative operation of V1401 and V1408.

Stage V1409 is a duo-triode with its two sections connected in parallel. The plates are connected together and to the 250-volt B+ line. The control grids are fed simultaneously through suppressor resistors R1435 and R1440. Bias voltage from the -375-volt bias supply is applied to the control grids through a voltage divider consisting of R1432 and R1436.

Cathode follower stage V1409 has two outputs in its cathode circuit. One output developed across R1437 is fed to the clipper amplifier and shunt regulator stages. This retangular 10-microsecond wide pulse is called the klystron

gate pulse. It will, after passing through several stages of processing and power amplification, be applied to the cathode of the klystron as a 10,500-volt, 10-microsecond wide beam pulse. The second output of V1409, developed across R1447, is fed to the receiver video amplifier blanking gate stage V401, as a receiver blanking pulse. This pulse will cause the receiver to be disabled during transmission of r-f output pulses to insure that transmitted energy will not be routed back into the radio beacon.

5. AMPLIFIER-MODULATOR AM-1701/GRN-9, CIRCUIT ANALYSIS.

Note

Amplifier-Modulator AM-1701/GRN-9 is used in Radio Set AN/GRN-9 only.

a. CLIPPER-AMPLIFIER AND SHUNT REGULATOR. - Ten-microsecond wide klystron gate pulses from the gate pulse generator stage are coupled through J1350 and coupling capacitor C1350 to the control grid of clipper amplifier V1350 (see figure 2-25). The clipper amplifier is biased to cutoff so that the base of the input gate pulse is clipped. Bias voltage is applied to the control grid through grid leak resistor R1350, by the resistive voltage divider consisting of R1352 and R1351 in series between the negative 375-volt supply and ground. A bypass capacitor, C1351, appears across R1351. The plate circuit consists of plate load resistor R1353 to the positive 250-volt supply. The positive 250-volt supply is connected directly to the screen grid. The cathode circuit consists of a variable gain resistor, R1364. R1363 and C1354 form a preemphasis network to provide for low-frequency compensation or droop elimination. This preemphasis is obtained by using negative feedback around the shunt regulator used to drive the klystron beam power amplifier. The feedback circuits provide for decreasing feedback with decreasing frequency. The variable gain control, R1364, is adjusted while observing the detected r-f output for minimum droop. The negative output pulse of this stage is coupled to the control grid of shunt-regulated amplifier V1353 through coupling capacitor C1352.

The circuit of the shunt regulator which drives the klystron beam power amplifier includes parallel-operated beam pentodes V1351 and V1352 in series with the triode-connected beam pentode, V1353. The plates of V1351 and V1352 are connected to the +250-volt supply through suppressor resistors R1359 and R1360 respectively. The screen grids are paralleled, coupled to the positive supply potential through screen-dropping resistors R1361 and R1362 connected in series, and coupled to the cathode by screen bypass capacitor C1353 .

The cathodes of V1351 and V1352 are connected together and are coupled to the plate of V1353 through resistor R1356. The droop eliminator preemphasis network C1354 and R1363 mentioned in the preceding paragraph couples this point which is the output of the shunt-regulated amplifier to the input of the shunt-regulated amplifiers (the control grid of V1353) through coupling capacitor C1352. The cathode of V1353 is at a negative 375-volt potential and its screen grid is tied to its plate, so that the tube operates as a triode. Directly in series with the control grid of V1353 is suppressor resistor R1355. Grid leak resistor R1354 is connected between the junction of C1352 and R1355 and the cathode. The grids of V1351 and V1352 are coupled to the plate of V1353 through suppressor resistors R1357 and R1358 respectively.

In the absence of a pulse, the bias voltage of V1353 is zero and the grid to cathode voltage of V1351 and V1352 is equal to the quiescent voltage drop across R1356. The screen voltage with respect to its cathode is the same as the voltage across C1353. The screen current drawn by both pentodes will be equal to the current flowing through the screen-dropping resistors R1361 and R1362.

Tube V1353 at zero bias has a far lower impedance than tube V1351 and V1352 biased negative. Therefore, the output of J1351 connected to -375 volts through the relatively low impedance of R1356 and V1353 assumes a large negative potential. This negative potential is coupled to the grid of the klystron beam power amplifier, V1302, which causes that tube to be cut off.

When the negative output gate of clipper-amplifier V1350 is applied to the control grid of V1353, V1353 is driven to cutoff, plate conduction ceases, and the tube impedance becomes infinitely high. As a result, the voltage across R1356 drops to zero, thereby changing the grid-to-cathode voltage of V1351 and V1352 from a negative value to zero.

The impedance of tubes V1351 and V1352 is now very low. The path of current flow is now from the filament of V1302 to its grid, to J1351 and then through tubes V1351 and V1352 to B+. Since tubes V1351 and V1352 have a low impedance, the output at J1351 is a large positive potential. This allows tube V1302 to conduct heavily and produce the high power klystron beam pulse.

The voltage rise at the cathode of V1351 and V1352 is equal to the pulse voltage at the plate of V1353. The voltage at the screen grid of V1351 and V1352 during pulsing will tend to remain the same since the voltage across capacitor C1353 cannot change instantaneously. However, due to reduction of

grid-to-cathode potential of V1351 and V1352 during pulse flow, the screen current will increase. The peak screen current can only be supplied by capacitor C1353 since at the pulse peak the screen voltage with respect to ground is larger than the B+ potential with respect to ground. Screen capacitor C1353 is large enough to prevent the peak screen current from causing a large change of voltage across it due to its loss of stored charge. During the period of pulse decay the stray capacitance across the shunt-regulated amplifier output which has been charge to the output peak voltage will discharge through the impedance of V1353.

b. CHARGING DIODE AND KEYED CHARGING TETRODE. - Each klystron beam pulse from the klystron beam power amplifier develops a negative voltage across R1303 that is applied as bias sufficient to cut off tetrode V1301 (see figure 2-26). Therefore, there is no current path through V1301 during beam pulses. Likewise, there is no current path through diode V1303 since a negative pulse cannot pass from plate to cathode in a diode.

When capacitor C1303 discharges during the application of pulse, its voltage drop decreases. When the beam pulse decays, capacitor C1303 is connected to the high-voltage power supply through the conduction path, V1301, and the diode, V1303, and charges up to approximately 11,000 volts, The low impedance of the charging diode minimizes the positive overshoot on the trailing edge of the beam pulse and provides a recharging path for coupling capacitor C1303. At any instant of time during the recharging period of C1303, the loss in voltage across C1303 will divide between V1301 and V1303 in proportion to their relative impedances. Capacitor C1303 will regain its charge lost during beam current flow and therefore regain its initial voltage. A meter, M1301, measures the charging current value of V1303, C1308 is a filter capacitor, and R1316 is a thyrite resistor used to protect the operator should M1301 become an open circuit.

c. BEAM PULSE POWER AMPLIFIER. - A positive keying pulse is applied to the control grid of V1302 from the shunt regulator (refer to figure 2-26). The magnitude of this pulse is large enough to drive the control grid highly positive. Thus the impedance of V1302 changes very rapidly from a very high value to a very low one, this change taking place within the rise time of the input pulse. During the period of pulse, the voltage developed across R1303 by the current discharged from C1303 is a grid bias large enough to keep V1301 cut off at its existing plate and screen-to-cathode voltage. Thus there is no

current flowing through V1301 during the pulse period. As a result, the entire voltage drop caused by the heavy conduction of V1302 is thrown across capacitor C1303 and the klystron. Since the voltage drop across C1303 cannot change instantaneously, a large negative going pulse is applied to the cathode of the klystron whose plate is a ground potential. This pulse, called the klystron beam pulse, causes the flow of beam current in the klystron. The time constant of the capacitor discharge path is such that for the longest group of pulses, the 24-pulse group, the voltage lost across C1303, due to the loss of its charge during the klystron conduction, is less than 10 percent of its initial charge value. During the time of pulse the cathode voltage of V1301 decreases with the plate voltage of V1302. Since the voltage across C1302 cannot change instantaneously, the screen-to-cathode voltage of V1301 will remain approximately the same, but the screen-to-ground voltage will decrease. When this happens, capacitor C1302 will begin to charge toward high-voltage potential through the screen dropping resistors, R1304 and R1305, thereby increasing the screen-to-cathode voltage. A spark gap, E1306, is placed across C1302 to prevent excessive voltage from destroying the capacitor.

As the pulse decays to zero, the impedance of V1302 becomes very high so that current ceases to flow through R1303 and the plate voltage of V1302 rises. As a result, the grid-to-cathode voltage of V1301 becomes zero. The screen-to-cathode voltage of V1301 does not initially change but as a result of the decrease in plate-to-cathode voltage of V1301, the screen current will increase. This increase in screen current is initially supplied by capacitor C1302.

The screen voltage of V1302 is obtained from an external source through relay K1302. Resistor R1301 and inductance L1301 form a high-frequency parasitic suppressor in series with the screen grid of V1302. A similar parasitic suppressor, R1302 in parallel with inductance L1302, is in series with the control grid of V1302.

Lamp DS1302 on the front of the amplifier-modulator panel indicates the operation of relay K1302. C1301 is an r-f bypass capacitor for the screen grid of V1302. C1310 serves as a high-voltage power supply source to provide a high pulse source to V1302 during the discharge cycle. R1313 is a screen voltage stabilizing resistor.

The high voltage is monitored by meter M1302 in series with multiplier resistors R1306 and R1307. The meter is calibrated directly in kilovolts. The meter measurement is shunted by a neon bulb, DS1304, to protect the operator

against excessive voltage should the meter circuit accidentally open. To monitor the beam pulse applied to the klystron, a voltage divier is used. The divider is frequency compensated, meaning that the voltage division is independent of frequency when the R-C time constant of the high-voltage section is equal to the R-C time constant of the low-voltage section. The ratio of this divider is 100:1 and is determined by R1308 in series with R1309 and potentiometer R1310. The compensating capacitors are C1304 and C1305 connected in series on the high-voltage side. Capacitors C1306 and C1307 are connected in parallel, and provide the necessary compensation on the low-voltage side. The divider is tapped at the junction of R1308 and R1309 and brought out to the amplifier-modulator chassis front panel.

Switches S1304A and S1304B, which close automatically when the amplifier-modulator drawer is withdrawn from the cabinet, short the high-voltage filter capacitors through resistors R1314 and R1315 to ground, in order to remove dangerously high voltages.

d. KLYSTRON. - The klystron tube, V1304, operating as a three-cavity amplifier, depends on the changes introduced in the velocity of a stream of electrons by alternately slowing some of the electrons and accelerating others - and using the transit time between two points to produce an alternating current (see figure 2-27). In the case of the klystron, V1304, the electron beam, following the space-charge focusing principle, is allowed to follow a trajectory determined by the initial convergent angle of the electron gun and by the mutual space-charge repulsion forces of the electrons. The beam comes down to a minimum, and then spreads out, so that it does not have a uniform diameter over its length. The pulse lengths used are too short to allow enough ionization to occur to neutralize the beam space-charge. The tube has three cavities that are tuned by changing the gap spacing. The overall r-f power gain for V1304 is well over 100 at its operating range of approximately 1,000 megacycles.

The following explains the manner in which velocity modulation is accomplished and the manner in which r-f energy is taken from a velocity modulated electron beam. Refer to figure 2-27.

To facilitate understanding of the following explanation, disregard the control grid (which applies to SAL-89 only) and assume that the klystron is keyed on. Electrons are emitted by the cathode and accelerated toward the electron collector by 12-kv potential applied between cathode and collector plate. An r-f

carrier signal of approximately 100 watts peak power is fed into the first resonant cavity causing a field of r-f energy to be set up between the modulating grids. The physical location of the modulating grids is such that the grids protrude into the cavity at points of maximum r-f potential difference. In this manner, the modulating grids become the capacitive loading elements in the cavity with large r-f voltages being induced across then when the first resonant cavity is driven by an r-f signal at resonant frequency. The high r-f voltage appearing between the modulating grids creates a radio-frequency field between grids. All electrons in the klystron beam current have essentially the same velocity as they approach the modulating grids. The electrons are accelerated or decelerated as they pass through the r-f field, depending on the polarity of the r-f field at the time the electrons are passing through the field. A number of electrons will maintain their original velocity because of the fact that they pass through the gap between modulating grids while the r-f field is at zero.

The klystron beam current, now consisting of accelerated, decelerated and inital velocity electrons, passes through the first drift space where the electrons composing the beam current are "bunched". Bunching occurs because of the fact that, after traveling a certain distance through the drift space, the electrons having increased velocities overtake electrons having reduced velocities.

The point at which maximum bunching occurs is called the "optimum bunching point". The klystron beam current passing the point of optimum bunching consists of alternating maximums and minimums of electrons occurring at the frequency of the modulating r-f signal fed into the first resonant cavity.

The beam current originates at the klystron cathode as a pure d-c stream of electrons. At the point of optimum bunching, the beam current consists of a d-c stream of electrons that is density modulated due to the bunching of electrons, and therefore contains energy varying at an r-f rate. In effect, a portion of the kinetic energy of the beam current has been made to vary at an r-f rate, and this r-f component of beam current is used to drive the second resonant cavity into r-f oscillation. The second resonant cavity is the equivalent of a high Q resonant circuit which takes energy from the beam current during the passage of a maximum of electrons, thereby decelerating the bunch, and feeds back energy to the beam current during the passage of a minimum of electrons, thereby accelerating the electrons at minimum density points in the beam. The second resonant

cavity and second drift space further increase the bunching of electrons so that the r-f component in the beam current will be increased, causing the third resonant cavity to resonate. The catcher grids in the third resonant cavity are located at the second point of optimum bunching. The r-f field between the catcher grids exerts a maximum decelerating force on the electron stream during the passage of the maximum number of electrons. The kinetic energy given up by the bunches of electrons during deceleration is added to the r-f field in the third resonant cavity. When the r-f field between collector grids reverses, exerting an accelerating force on the electrons in the beam current, a mimimum number of electrons are passing between collector grids. The amount of acceleration applied to an electron passing between the catcher grids is dependent on the potential difference between grids. This difference in potential is the same, except for reversal of polarity, when the electron stream is being accelerated as when the electron stream is being decelerated. The total energy added to or taken from the electron beam is a function of the product of accelerating force and the quantity of electrons being acted upon by this force. The number of electrons between catcher grids during the time energy is being transferred from the electron stream to the r-f field is greater than the number of electrons between the catcher grids during the time that energy is being transferred from the r-f field to the electron stream. Therefore, there is a net gain in r-f energy in the resonant cavity. An r-f pickup loop inserted in the wall of the third resonant cavity couples the r-f power from the third resonant cavity to a coaxial line feeding into the control duplexer.

After the klystron beam current passes the catcher grids it still contains a great deal of kinetic energy which is dissipated as heat when the electrons strike the collector plate. Velocity modulation is a means of converting kinetic energy, present in an electron beam due to the high voltage between klystron tube elements, into r-f energy. If there is no r-f drive power fed to the input cavity, or if the klystron is not properly tuned, none of the kinetic energy in the klystron beam current will be converted to r-f power, and the total kinetic energy present will have to be dissipated by the electron collector plate. Under these conditions the collector plate will be dangerously overheated, and permanent damage may be done to the klystron. Under normal operation a portion of the kinetic energy in the klystron beam current is converted to r-f power and fed to the antenna. The remaining energy left in the klystron beam current can easily be dissipated by the electron collecter plate, cooling fins and blower system.

Coincident with the timing of the 12,000-volt klystron beam pulse at the klystron cathode, a modulated r-f pulse from the second keyed r-f amplifier is applied to the klystron input cavity. In the klystron, this modulated r-f pulse modulates the high-powered klystron beam pulse to provide a maximum 6,000-volt r-f modulated klystron output to the duplexer and antenna.

Because of high gaseous conditions, usually caused by inherent properties of the tube and the fact that complete evacuation of the tube is not possible during manufacture, it is necessary to operate a new or idle klystron for approximately 20 minutes to normalize the tube characteristics. To prevent the ionization of gas, which could cause great damage to the tube, a procedure referred to as "aging" is undertaken to drive the gas molecules back into the wall of the tube before a full beam voltage is applied.

When switch S1303A is in position "1/3", both R1312 and R1311 are in series with the pulse signal. This limits the positive drive on the grid to near zero volt. Meanwhile switch S1303B in any position except NORMAL opens the coil circuit of relay K1302 and thereby removes the +700-volt screen bias from the amplifier V1302. This circuit operates as a voltage divider network enabling control of the high voltage placed across the klystron. The charge path of the 12,000-volt supply is through V1301, through the charging capacitor C1303, and through the charging diode V1303 to ground. The impedance of V1302 is in series with the klystron impedance. With S1303A in the "1/3" position, the high-voltage supply divides between the amplifier, V1302, and the klystron, V1304, in approximately 2:1 proportions.

The load of the klystron beam power amplifier consists of the klystron,V1304, and capacitor C1303. The diode and the divider present very high impedances to the output pulse. On the discharge cycle C1303 delivers one-third of the voltage stores across it (12,000 volts) to the klystron,V1304. With switch S1313A in position "2/3", only R1311 is in series with the pulse signal and K1302 is still de-energized so that now the voltage division is approximately 1:2 and the beam voltage of the klystron V1304 increases to 2/3 of the 12,000-volt power supply.

Note

> Paragraphs 6 and 7 describe circuits employed in the transmitter portion of Radio Sets AN/GRN-9A and AN/SRN-6. All references to Radio Set AN/GRN-9A also apply to Radio Set AN/SRN-6 unless specifically stated to the contrary.

6. FREQUENCY MULTIPLIER-OSCILLATOR CV-589/URN, CIRCUIT ANALYSIS.

Refer to Section 7 of this manual for complete schematic diagrams of the frequency multiplier-oscillator video chassis and r-f chassis. Refer to figure 2-26.1. Radio Sets AN/GRN-9A and AN/SRN-6 Transmitter Output Simplified Schematic Diagram, for a simplified functional schematic of the circuits described in the following paragraphs.

a. CARRIER GENERATING CHAIN. - Circuits of the carrier frequency generating chain, consisting of stages V1501 through V1504, are identical in Radio Sets AN/GRN-9 and AN/GRN-9A. Refer to the circuit description of these stages given forFrequency Multiplier-Oscillator CV-590/GRN-9.

b. SHAPED PULSE GENERATOR. - Stages V1402 through V1406 are the same in both Radio Sets AN/GRN-9 and AN/GRN-9A. Refer to the circuit description of these stages given forFrequency Multiplier-Oscillator CV-590/GRN-9.

The cathode follower output stage consists of two pentodes, V1407 and V1411, connected in parallel. By operating two tubes in parallel the output impedance of the 3.5-microsecond shaped pulse generator is lowered. It is essential that the shaped pulses applied to the grid of the klystron in the amplifier-modulator be derived from a low impedance source. Potentiometer R1471 and capacitor C1424 form a compensating network in the grid circuit of the cathode follower output stage. Potentiometer R1471 is adjusted to eliminate "droop" in the north and auxiliary reference bursts. It is required that the amplitude of any pulse in the north reference burst of 24 pulses shall not deviate from the average amplitude by more than ± 2.0 percent. Any tendancey toward pulse droop in the output of the radio set may be compensated for by adjusting R1471 to introduce enough pulse boost to equalize pulse droop.

The shaper network connected between the cathode of V1406 and grids of V1407 and V1411 has the same circuit configuration as the shaper network employed in Frequency Multiplier-Oscillator CV-590/URN, but the values of inductance and capacitance are not the same. The delay time through the shaper network is approximately 2.8 microseconds. Although coils L1401, L1402 and L1403 have adjustable iron cores, they are set to the inductance values shown on the schematic and are not to be adjusted in the field.

c. KEYED R-F AMPLIFIERS. - R-f amplifiers V1505 and V1506 are similar to corresponding stages in Radio Set AN/GRN-9 except for the method of keying the r-f amplifiers and the shape of the keying pulse. Plate current in both r-f

amplifiers is cut off by a positive cathode bias of approximately 25 volts obtained from the voltage divider consisting of R1456 and R1457. Negative 10-μsec pulses from T1404 are applied to the cathodes of r-f amplifiers V1505 and V1506 to override the positive cathode bias and key on plate current. A constant r-f carrier signal is applied to the grid line of r-f amplifier V1504, from tripler stage V1504. The r-f carrier signal is passed through the r-f amplifiers only during the time that a negative keying pulse is present on the cathodes of the r-f amplifiers.

The r-f output signal of the frequency multiplier-oscillator, which consists of 10-μsec pulses of r-f energy at the carrier frequency, is fed to the amplifier modulator.

d. VOLTAGE REGULATOR STAGE V1410. - Dual triode V1401 is used as a voltage regulator to provide 150 volts B+ for the oscillator and doubler stages in the frequency multiplier-oscillator r-f chassis.

e. GATE PULSE GENERATOR. - Pulses from the coder-indicator are fed through delay lines DL1401 and DL1402 in series to the one-shot multivibrator stage consisting of tubes V1401 and V1408. The one-shot multivibrator, which is identical in circuitry to the same stage in Frequency Multiplier-Oscillator CV-590/GRN-9, generates one pulse 10 μsec wide for each trigger pulse applied to the grid of V1408.

Cathode follower stage V1409 consists of a twin triode with both triodes operating in parallel. Pulses from the plate of V1408 are coupled to the grids of V1409 through capacitor C1414 and parasitic suppressors R1435 and R1440. Approximately 25 volts of negative bias is applied to the grids of V1409 from a voltage divider consisting of R1433 and R1436. Pulse transformer T1404 is the plate load of V1409, and couples the 10-μsec output pulse from the plate of V1409 to the cathodes of r-f amplifiers V1505 and V1506. Resistors R1456 and R1457 serve as a voltage divider on the 250 v d-c bus, and provide a source of positive bias voltage which is fed through the secondary of T1404 to the cathodes of r-f amplifiers V1505 and V1506. Capacitor C1407 provides a low impedance path to ground from terminal 3 of T1404 for 10-μsec pulses induced in the secondary of T1404. A second output from V1409 is taken off the unbypassed cathode resistor, R1458, and fed to the receiver video amplifier to provide a 10-μsec blanking pulse.

7. AMPLIFIER-MODULATOR AM-1701/URN, CIRCUIT ANALYSIS.

The amplifier-modulator consists of r-f power amplifier V1304, a regulated bias supply, and associated control circuits. R-f power amplifier V1304

employs a SAL-89 type klystron, which is a three-cavity amplifier having a control grid used to density modulate the klystron beam current, and an r-f input jack in the first cavity used to velocity modulate the klystron beam current. A constant negative potential of 12 kv is applied to the klystron cathode. Klystron beam current is cut off by approximately 120 volts of negative bias developed in the regulated bias supply and fed to the klystron control grid through the secondary of pulse transformer T1372. Shaped 3.5-μsec pulses, from cathode follower stage V1407 and V1411 in the frequency multiplier-oscillator, are fed to the primary of pulse transformer T1370. Positive pulses from the secondary of pulse transformer T1372 are applied between the control grid and cathode of klystron V1304, causing the klystron to conduct beam current. The instantaneous value of beam current is directly proportional to the instantaneous voltage of the 3.5-μsec shaped pulse. In this manner, the flow of beam current is density modulated by the 3.5-μsec shaped pulse on the klystron grid. As the klystron beam current passes through the first resonant cavity of the klystron it is velocity modulated by the 10-μsec r-f pulse fed into the r-f input jack on the klystron input cavity.

The output of the klystron, consisting of specially shaped r-f pulses having a minimum peak power of 7.5 kw and a repetition rate identical to the repetition rate of the pulse train at the output of the coder indicator, is fed to transmission line tuner Z1303. Double-slug tuner Z1303 provides a means of matching the output impedance of the klystron with the impedance of the transmission line filters, Z1165 or Z1157, in the control duplexer. The r-f output signal is fed, via coaxial cable, from the amplifier-modulator to the control duplexer. The regulated power supply, included in the amplifier-modulator to provide negative bias between klystron cathode and grid, is a conventional series-regulated supply similar in operation to series regulated supplies described elsewhere in this manual. In place of rectifier tubes employed in other series-regulated supplies in the radio set, crystal-type rectifiers CR1370 and CR1371 are used as power supply rectifiers. In addition to saving space and reducing heat dissipation, crystal-type rectifiers eliminate the need for filament transformers. The output of the bias supply is applied between cathode and control grid of the SAL-89 klystron, with the positive terminal connected to the cathode and the negative terminal connected to the grid of SAL-89 through the secondary of T1372. As the cathode of the klystron is operated at -12kv above ground, all components in the bias supply are insulated from ground to withstand potential

differences in excess of 12kv between components of the bias supply and ground. Power for the primary of bias supply transformer T1371 is obtained from a 120 volt, a-c secondary winding on transformer T1370, which provides filament power to the klystron. Insulation between the primary and secondary of transformer T1370 is capable of withstanding voltages in excess of 20 kv rms; therefore, bias supply transformer T1371 can be a conventional low-voltage power supply transformer having low-voltage (1, 800-volt rms) insulation between windings. See figure 2-26. 2.

The average output of the regulated bias supply is five milliamperes at 120 volts dc. During the application of the shaped pulse to the klystron grid the current supplied by the regulated bias supply reaches a peak value of approximately 50 ma.

8. CONTROL DUPLEXER C-2226/GRN-9 AND C-2225/SRN-6 CIRCUIT ANALYSIS.

The duplexer (see figure 2-28) is a passive network which permits both the transmitter and receiver to be connected simultaneously to one antenna. Pulsed r-f transmitter output from the klystron r-f amplifier is fed to a transmission filter consisting of a pair of tunable resonant cavities critically coupled. The transmission filter is located in the line between the transmitter and the antenna, with the receiver line branching off on the antenna side of the transmission filter. The performance standards for the filter system are as follows:

a. Signal loss at transmitter frequency, 1. 4 db maximum.

b. Response at transmitter frequency ±0. 2 mc is within 3 db of response at transmitter frequency.

c. Response at transmitter frequency ±0. 75 mc is a minimum of 20 db down from response at transmitter frequency.

d. Transmitted signals are essentially completely rejected at receiver frequencies (transmitter frequency ±63 mc).

e. Temperature operating range from -54° to 65°C. (ambient).

Spaced one-half-wave length from the output terminal of the filter is a "tee" connection to which are connected the receiver preselector cavities. As the transmission filter is tuned 63 mc above or below the receiver frequency it appears as an open circuit at the receiver frequency. From the "tee" junction the transmitter output is fed to the antenna and transmitted. At the receiver frequency the preselector cavities are an odd number of quarter-wave lengths long so that they act as a short circuit across the main line, and receiver frequency is routed to the radio receiver. In effect transmitter frequency travels from the transmitter down the line to the antenna; the receiver preselector cavities as far as transmitter frequency is concerned do not exist. Receiver frequency is picked up by the antenna and is routed directly to the receiver preselector cavities; the transmission filter does not exist electrically at this frequency.

Samples of the klystron incident and klystron reflected voltage are fed via directional coupler DC1151 to test jacks P1152 and P1151 respectively. In the same manner samples of the antenna incident and antenna reflected voltages are fed via directional coupler DC1156 to test jack P1175 and P1171. These test jacks are used during klystron and duplexer tuning as described in Section 7.

Control circuits contained in the control duplexer are described in paragraph 11.

9. ANTENNA GROUPS.

a. GENERAL DESCRIPTION. - Each of the antenna groups described in this paragraph (that is, Shore Antenna Group OA-1548/URN (high band), Shore Antenna Group OA-1547/URN (low band), and Shipboard Antenna Group OA-1545/SRN-6 (low band)) consists of an antenna proper, an antenna pedestal, and a bearing antenna servo system. In addition, Shipboard Antenna Group OA-1545/SRN-6 includes pitch and roll stabilization servo systems. Each of the three antenna groups includes a speed control system, which maintains the induction motor (spin motor) serving to drive the rotating cylinders of the antenna at a constant speed. The antenna receives the interrogation pulses transmitted by the aircraft, and transmits the radio beacon reply pulse-pairs, the 15-cps and 135-cps reference bursts, and the radio beacon identification

call. In addition, the antenna supplies the 15-cps and 135-cps modulation superimposed on the transmitted r-f pulse-pairs. For a description of the antenna output pattern, refer to paragraph 2b of Section 1.

(1) The antenna proper includes the central array, which contains the primary radiating elements, consisting of four dipoles mounted in a stationary fibreglas cylinder. The 15-cps modulation is accomplished by parasitic reflectors mounted in a fibreglas cylinder, which rotates around the central array at a constant speed of 900 rpm. The 135-cps modulation results from another such cylinder mounted outside the cylinder containing the 15-cps reflectors and rotating with it. The 135-cps reflectors are spaced at 40° intervals around the cylinder. Refer to Section 1, paragraph 14.

(2) The rotating shaft carrying the parasitic element cylinders has a pulser plate attached to it. The pulser plate carries a total of nine soft iron slugs (see figure 2-29.1). These slugs, passing through pulser coils, generate pulses that, in turn, trigger the burst pulse forming circuits in the coder-indicator unit of the radio beacon. The pulser plate, in combination with the pulser coil assembly, is known as the reference pulse generator, since the trigger pulses generated by it, as noted above, initiate the formation of the reference burst pulses. The precise sequence and timing of the trigger pulses generated by the reference pulse generator are determined by the spacing of the soft iron slugs about the outer edge of the pulser plate. The reference pulse generator provides two sets of references corresponding to the 15-cps and 135-cps components of the bearing signal. These 15-cps and 135-cps reference pulses trigger the coder-indicator with every 40° rotation of the cylinders containing the parasitic reflectors. The 15-cps pulse triggers the coder-indicator 15-cps burst pulse forming circuit once in every 360° rotation of the cylinders. The 135-cps pulse triggers the coder-indicator 135-cps burst pulse forming circuit once every 40° rotation, after the 15-cps trigger pulse. Note that the eight 135-cps slugs are spaced 40° apart from each other about one edge of the pulse plate. The 40° point between the first and eighth 135-cps slugs, on that edge of the pulse plate, is blank. The north or 15-cps slug, located on the other edge of the pulser plate, occupies this point. (Refer to figure 2-29.1.) Thus, the north pulse will occur midway between the first and eighth 135-cps or auxiliary pulses. The north pulser coil is placed above the auxiliary pulser coil, causing the 15-cps pulse to be generated only in the absence of the 135-cps pulse. The 15-cps and 135-cps reference trigger

pulses fed into the coder-indicator initiate the formation of reference burst pulses, which are processed, fed to the transmitter, shaped in the transmitter circuits, and returned to the antenna array in the form of r-f pulses for transmission.

(3) The antenna bearing servo system functions to maintain the reference bursts and r-f modulation in their proper relationship to magnetic north. Compensation for magnetic variation is set in manually, by means of a dial on the coder-indicator unit, for both shipboard and shore antenna groups. The shipboard antenna bearing servo system also uses the ship's course signal to automatically compensate for the movements of the ship.

b. GENERAL THEORY OF SERVO AND SYNCHRO SYSTEMS. - To facilitate an understanding of the shipboard and shore antenna control systems, a brief discussion on general servo systems is given below.

(1) GENERAL. - The transmission of the angular position of a mechanical shaft to a remote location may be accomplished, electrically, by what is generally known as a synchro system. If the voltage representing the angular position of the controlling shaft is to be amplified before it is applied to the controlled shaft, a so-called servo system is used instead, Servo systems are essentially high-gain power amplifiers operating on the closed loop or error-sensitive principle in which the action of the power amplifier is governed by an error that is developed when there is an angular difference between the controlling and the controlled shafts.

(2) SYNCHRO TRANSMITTER. - The function of a synchro transmitter is to transmit electrical data corresponding to the angular position of its rotor. As shown in figure 2-29.2, a synchro transmitter consists of a single winding rotor and a Y-connected three-winding stator. The stator is wound so that the three windings are displaced by 120° about the axis of the rotor shaft. When an a-c voltage is applied to the rotor, electrical signals induced in the stator windings are proportional to the angular position of the rotor.

(3) SYNCHRO RECEIVER. - The electrical characteristics of a synchro receiver are identical to those of the synchro transmitter previously discussed. Physically, however, the receiver differs from the transmitter in that it is equipped with an inertial damper and has very low friction losses. The inertial damper is used to prevent the rotor from overshooting caused by any sudden changes in the received data. If a sudden change in the incoming voltages causes the receiver to alter its position abruptly, a damping ring exerts a

braking action on the oscillating rotor, stopping its movement. When the change in incoming voltage results in a steady movement, the ring moves with the shaft, and no damping action occurs. The synchro receiver is normally connected in parallel with the synchro transmitter to repeat transmitter data.

(4) SYNCHRO CONTROL TRANSFORMER. - The bearing (azimuth), pitch and roll servos of the shipboard and shore antenna control units of Radio Sets AN/GRN-9, AN/GRN-9A and AN/SRN-6 employ control transformers in lieu of synchro receivers. As indicated in figure 2-29.2, a synchro control transformer is similar to a synchro transmitter and synchro receiver except for some physical and electrical differences. The a-c command voltage is not applied to the rotor winding of the synchro control transformer. Instead, a voltage is induced in the rotor winding by the current flow in the stator windings, and the rotor in turn generates an output control voltage. This control voltage reaches a null (zero-volt output) when the control transformer rotor is displaced 90° from the rotor of the transmitter synchro. When the rotor of a transmitter synchro is displaced and therefore out of alignment with the control transformer rotor, the voltage that appears across the control transformer rotor winding varies at the sine of the angle of displacement.

The control transformer is used where it is desired to obtain a voltage indicative of angular position only, this voltage being fed to a servo amplifier that in turn drives a motor geared to restore the alignment of the shaft of the control transformer.

(5) DIFFERENTIAL SYNCHRO TRANSMITTER.

(a) A differential transmitter is used in the Radio Sets AN/GRN-9, AN/GRN-9A and AN/SRN-6 control units rather than a synchro transmitter. The differential synchro transmitter provides a means of adjusting the angular position of the receiver rotor with respect to the transmitter rotor. The stator of the differential transmitter is similar to that of the regular synchro transmitter or receiver. However, the differential transmitter rotor differs physically and electrically from the rotor of conventional synchro units.

(b) The synchro differential sometimes is employed between a synchro transmitter and a synchro control transformer, as shown in figure 2-29.3, between a synchro transmitter and a synchro receiver, or in parallel with the control transformer only. The stator represents the primary while the rotor represents the secondary of a variable transformer. Their transfer ratio is approximately 1 to 1. In the arrangement shown in figure 2-29.3, the signal

from a synchro transmitter is fed to the stator of the differential and its output signal is fed to the stator windings of a control transformer or synchro receiver. The variable introduced in such a control system by the differential transmitter is a function of the angle of the synchro differential rotor position, which can add to or subtract from the angle introduced by the synchro transmitter.

(c) The following example should clarify the explanation given above: Assume that the differential is connected between a transmitter and a receiver as shown in figure 2-29.3. It is seen that the differential is at the electrical zero position, and that the transmitter rotor has been turned 240° counterclockwise. Since the differential is at zero, no correction factor is added, and the receiver rotor is therefore aligned with the transmitter rotor. On the other hand, if the differential rotor is turned 120°, and the transmitter rotor is set at 0°, as shown in figure 2-29.4, the receiver rotor will turn clockwise to the 240° position. This occurs since R1 of the differential is connected to S1 of the receiver, and the transmitter rotor being on 360° results in a subtraction of the 120° displacement of the differential rotor from this amount (360°), thereby causing the receiver rotor to assume the 240° position.

(d) Whenever the differential is directly connected between the transmitter and receiver, the position of the receiver shaft will be equal to the position of the transmitter shaft MINUS the position of the differential. By reversing S1-S3 and R1-R3 of the differential, the differential position will instead ADD to the transmitter reading. Since the antenna control system does not employ a synchro transmitter, the differential transmitter is connected to the control transformer as shown in figure 2-29.5.

c. RADIO SET AN/SRN-6 ANTENNA SERVO SYSTEMS (SHIPBOARD).

(1) BEARING SERVO SYSTEM. - The bearing servo system (figures 2-29.6 and 2-29.7) used with the stabilized shipboard antenna works as follows: The angular position signals for true north transmitted from the ship's gyro compass are continuously transmitted through the ship's bus to the radio beacon. The magnetic variation subassembly located in the coder-indicator unit corrects the ship's gyro compass information for magnetic north. The signal maintains the radio beacon's 15-cps reference pulse coil subassembly fixed with respect to corrected (magnetic) north. The magnetic correction signals are manually set into the 1- and 36-speed 1HDG differential generator of the magnetic variation subassembly. The sum of the gyro compass and magnetic variation

signals is forwarded to the azimuth (bearing) 1- and 36-speed, 1HCT's (control transformers) in the antenna base. As long as the rotors of the 1HCT are at the same effective angular position as that of the 1HDG's (differential generators) after summing the signals of the ship's gyro compass and magnetic variation signals, no control transformer output signal is sent to the bearing servo amplifier. Should the equilibrium be upset owing to displacement of the rotors of the 1HDG's to new positions by changing the setting of the magnetic variation unit, or should the ship's course change, an error voltage will be introduced and transmitted from the 1HCT's to the servo amplifier.

The bearing servo amplifier, having received its signal, sends power to the servo motor, and causes it to rotate in the proper direction to restore the rotors of the 1HCT's to the zero signal position. At the same time the 1HCT's are being restored to equilibrium, the gear train rotates the pickoff coils of the pulser and plate assembly, enabling the 15-cps reference of the transmitted signal to be oriented to magnetic north as dictated by the ship's course and magnetic variation subassembly.

(2) MAGNETIC VARIATION SUBASSEMBLY. - The magnetic variation subassembly, mounted on the front panel of the coder-indicator, is composed of: two 1HDG synchro-differential generators, the rotors of which are geared together in a ratio of 36 to 1; a dial calibrated in 360° of bearing which is attached to the rotor of the 1-speed 1 HDG; and a dial calibrated from 0° to 10° attached to the rotor of the 36-speed synchro. Both are displayed concentrically on the front panel of the coder-indicator.

Note

> The magnetic variation subassembly, a basic part of the antenna group, is located in the coder-indicator to facilitate access by the operator.

The use of the dual-speed synchro transmission system provides greater accuracy in determining shaft angles. For example, while the dial connected to the 1-speed synchro control transformer can be adjusted quite closely to the actual angular position of the shaft, the use of a 36-cpeed gear ratio with a corresponding dial calibrated from 0° to 10°, and which makes one complete revolution for every 1/36th revolution of the coarse adjustment (1-speed) dial, increases the reading accuracy. In other words, one revolution of the fine control dial represents 10° on the coarse adjustment dial, thus enabling shaft positions to be read with 36 times the accuracy.

Rotation of the dials on the magnetic variation subassembly by the operator transmits a command to the synchros, which in turn causes the pulser (pickoff) coils of the pulser and plate assembly on the antenna to rotate a corresponding amount (refer to paragraph 9a above), thereby fixing the 15-cps reference of the transmitted signal to the new magnetic north position indicated.

(3) SYNCHRO ZEROING.

(a) GENERAL. - A dual-speed, even gear ratio servo system requires the use of a synchronizer to crossover system. The function of this system is to determine whether the 1-speed control transformer voltage or the 36-speed control transformer voltage is fed to the servo amplifier. The antenna servos synchronizer is designed to permit the 36-speed transformer voltage to be fed to the servo amplifier only if this voltage is below 2-1/2 volts. When the differential shafts are considerably out of correspondence, resulting in an output from the 1-speed control transformer in excess of 2-1/2 volts, the 36-speed transformer voltage is attenuated and only the output of the 1-speed control transformer is introduced to the servo amplifier. When the output of both transformers is small, the voltage fed to the amplifier will be essentially that coming from the 36-speed transformer.

(b) ANTISTICKOFF VOLTAGE. - The use of an even gear ratio between the fine and coarse control transformers presents a problem in synchronizing the servo system. The use of a single dial, calibrated in degrees, fastened to the coarse control transformer shaft provides only a fair degree of accuracy, while a second dial fastened to the fine control transformer shaft, and so calibrated that one revolution of the fine control transformer equals 10° of the coarse control transformer, provides a means of reading the position of the controlled shaft with 36 times the accuracy.

1. Figure 2-29.8 shows that when the fine control transformer voltage is combined with the coarse transformer voltage, they cross the horizontal axis simultaneously at 0° and at 180°. At 0°, the output voltage of both the fine and coarse control transformers are of the proper polarity to drive the servo to null. The 0° crossover point is therefore said to be stable, since the two voltages cross the time/degree axis at the same time and in a direction with increasing amplitude. Note that at the 180° position on the time axis, the two voltages cross in opposite directions. The 1-speed transformer voltage tends to drive the servo to null at 0° while the 36-speed tends to drive the servo toward 180°.

2. The fact that the fine-control transformer voltage is fed to the servo only when the amplitude of the coarse-control transformer voltage is below 2-1/2 volts causes a problem, since the two voltages reach this amplitude together at 0° and at 180°. Assuming that the servo is resting at a position 180° from its null position, if the 36-speed transformer voltage is then fed to the servo amplifier in the absence of a large 1-speed transformer voltage, the servo would be synchronized at a false null of 180°. This difficulty is overcome by adding what is called an antistickoff voltage to the 1-speed transformer voltage as shown in figure 2-29.9 to prevent the voltages from crossing the axis at the same time.

3. When a voltage of the proper amount and phase is added to the 1-speed transformer voltage, the 1-speed voltage is shifted 2-1/2° to the left of zero and 2-1/2° to the right of the 180° point on the time/degree axis, corresponding to a 90° shift or 1/4 revolution of the 36-speed control shaft. Once this shifting takes place, the two voltages plus the antistickoff voltage appear shifted as shown in figure 2-29.10. The crossover point at 0° is now stable, while the other position of correspondence occurs at 185° and not at 180°. Therefore, the addition of the antistickoff voltage to the 1-speed control transformer voltage eliminates the problem of false nulls of the synchronizing network use.

(4) ROLL AND PITCH SERVO SYSTEM.

(a) Roll and pitch information is fed from the ship's bus to the antenna stabilization servo system through the respective control transformer of the pitch or roll control system, as illustrated in the block diagram of figure 2-29.11. The output of the control transformer is fed to a phase-detector, and the resultant error voltage is then fed through the magnetic amplifier to the servo motor. The servo motor, through its associated gear train, moves the antenna to its corrected position. The gear train, at the same time, nulls the error signal at the control transformer through the 1-to-2 gear box train. The rate feedback loop is provided through the tachometer to eliminate oscillation.

(b) The magnetic amplifier for the roll and pitch are identical electrically, and function similarly to the bearing magnetic amplifier.

(5) WARNING LIGHT. - Because of the inaccessibility of the antenna and control unit to the operator on shipboard during normal operation, a warning light, DS602, marked STEADY ON NORMAL, has been installed on the front panel of the coder-indicator. This warning light indicates malfunctioning of circuits within the antenna and control unit resulting in a blown fuse or loss

of reference voltages or operating power. When the light is on steady, it indicates that the antenna and antenna control circuits are functioning normally. Trouble is indicated by the lamp's blinking on and off. The blinking on and off of the warning light is accomplished by placing the warning light in a series circuit with the contacts of the relays of the following associated circuits (see figure 2-29.12): roll and pitch reference; bearing reference; spin motor; bearing, roll and pitch servo loops. The thermal cutout switch makes and breaks if the series circuit is open, thus producing the blinking of the warning light.

(6) ANTENNA SPEED CONTROL (SHIPBOARD). - Shipboard Antenna Group OA-1545/SRN-6 utilizes a speed control system. This system is identical to the one used in the shore antenna groups. The theory of operation of this system is discussed in paragraph 9h(1)(a).

d. MAGNETIC AMPLIFIER, GENERAL THEORY.

(1) SATURABLE REACTORS.

(a) Magnetic amplifiers, like vacuum tube amplifiers, have their characteristic building blocks. The fundamental unit for magnetic amplifiers is the saturable reactor. In its simplest form the saturable reactor has two windings (see figure 2-29.13). The a-c winding is in series with a power source and a load, and is the winding which handles the power. It is analogous to the plate circuit of the vacuum tube amplifier. The current that flows in this loop is a function of the impedance of this winding, which depends on the saturation of the magnetic core. This, in turn, is controlled by the d-c current in the second winding, called the control winding. The counterpart of this element in a vacuum tube is the control grid. The control current, therefore, acts a valve for the a-c current. Thus, a small amount of d-c power can control a much larger a-c power. There are many variations of this fundamental building block to obtain different effects and, just as vacuum tubes may have grids to get different characteristics, saturable reactors may have many control windings. Some of the variations are discussed in the following paragraphs.

(b) Reactors are usually designed and connected so that the transformer action from the a-c power circuit to the control circuit is kept to a minimum. This is accomplished by connecting two reactors so that the voltages induced in the control windings cancel each other, as illustrated in figure 2-29.13, or by using two magnetic paths in one core, as illustrated in figure 2-29.14. The a-c flux in the center leg of the magnetic core caused by winding (1) is cancelled by the equal flux from winding (2). This cancellation is not obtained for certain

harmonics. These are fairly small, however, and usually cause little difficulty. Thus, there is a negligible induced voltage coupled back from the a-c winding, and a unilateral control device has been obtained. Many magnetic amplifiers have this feature built in. This is true of the bearing magnetic amplifier described in this book. Note that in the reactor schematic of figure 2-29.13 zero a-c coupling between control and output (a-c) winding is represented by drawing the two windings prependicular to each other. This representation is being used in some of the diagrams that follow.

(c) A variation of the reactor of figure 2-29.13 may be obtained by combining it with an identical unit to give a reactor with zero output voltage for zero d-c control current. In addition, in this arrangement the phase of the output voltage reverses when the d-c control current reverses. This is illustrated schematically in figure 2-29.15. A bias winding has been added, the purpose of which is to establish a d-c saturation flux in the magnetic flux path. With no d-c control current, the saturation of each half of the a-c winding is the same and therefore the bridge, consisting of the center-tapped secondary of the input transformer and the center-tapped a-c winding of the saturable reactor, is balanced. No current will flow through the load. The d-c control windings are wound oppositely so that a given d-c control current will add to the bias flux in core A of the reactor and subtract from the bias flux in core B. Unequal saturation will then result in the two halves of the a-c windings and the bridge will be unbalanced. This results in a flow of current with a given phase through the load. If the control current is reversed, then the flux in core B will be increased and that in core A will be decreased. This unbalances the bridge in the reverse direction, and the load current will reverse in phase. In addition, the output voltage remains proportional to the control current within fairly wide limits.

(d) The reactor schematic diagram of figure 2-29.15 is sometimes simplified so that the double core arrangement is not shown. (See figure 2-29.16.) There are many variations of this balanced reactor. It should be established that it is not necessary to obtain the bias current by means of a separate winding. Often the bias current may be a quiescent current in the control winding. In some reactors bias is obtained by rectifying the current in each a-c winding (see figure 2-29.17) and feeding the resultant direct current back to establish a bias flux. This can be done since there is always a quiescent current in these branches, even when there is zero d-c control current. In addition, this

constitutes feedback. For example, current in branch A is rectified by the associated bridge rectifier and is fed to the feedback winding L_a. If the current in A increases, the bias flux in the core also increases. This further increases the core saturation, which increases current in A still further. A similar set of steps occurs for current in branch B. The operation described constitutes positive feedback. In effect, we have increased the gain of the magnetic amplifier, since the bridge unbalance is greater for a given control current than what it would have been without the feedback winding.

(e) Negative feedback could be obtained by feeding rectified current A back into core B and rectified current B into core A. Many other arrangements are possible, such as having separate feedback and bias windings. This arrangement is necessary where only a small amount of feedback is desired, and as a result the bias current from this source is correspondingly small. Sometimes a stabilizing winding is added when the unit is to be used as part of a servo system. It can be shown that when this winding is loaded with an inductance, it has the same effect that an integral control network has in direct-coupled servo stabilization.

(2) BRIDGE RECTIFIERS.

(a) It is seen that when a small amount of d-c power is put into a magnetic amplifier a larger amount of a-c power is produced. To get further amplification, it is then necessary to use a phase-sensitive rectifier to convert the a-c output power to d-c current for the control of the next magnetic amplifier stage. Bridge rectifiers are generally used for feedback purposes and for obtaining d-c bias currents, and the rectifier is an important unit in magnetic amplification.

(b) A bridge rectifier is a full-wave rectifier and is extensively used in magnetic amplifier applications because of its convenience. It is efficient and requires no center-tapped source. Its principle of operation is described as follows (see figure 2-29.18): Assume a given instant when the generator voltage is of the polarity shown in A. Diodes 1 and 2 conduct, creating the conduction path indicated by the arrows. Diodes 3 and 4 are inoperative, since they have a high impedance to this polarity, and current passes through the load from bottom to top. When the alternating current reverses, as in B, diodes 3 and 4 conduct as shown by the arrows, while 1 and 2 are nonconducting. Note that the direction of current through the load is from bottom to top as before, so that on both halves of a cycle the top of the load resistor is positive with respect to the bottom. The current through the load has now been full-wave rectified.

(3) SELF-SATURATING REACTOR CIRCUITS. - Magnetic amplifiers frequently use self-saturating circuits in which a half-wave rectifier is inserted in series with each a-c power winding. In the simplest circuit of this type, shown in figure 2-29.19 (a), the load current is limited to half-cycle pulses. Usually two rectifiers are used, as in (b), to provide full-wave output and to reduce the a-c voltage induced in the control circuit. These rectifiers may also serve as two of the arms of a bridge rectifier, as in (c), if it is desired to supply the load with direct current.

e. ANTENNA SERVO SYSTEM (SHORE).

(1) BEARING SERVO SYSTEM.

(a) The bearing servo system of the shore beacon serves primarily as an accessible electromechanical means of adjustment to insure that any calibrated AN/ARN-21 receiver will receive the proper magnetic bearing. The 15-cps reference burst signal of the radio beacon is pulsed so that the last pulse of the train of pulses of the 15-cps burst will occur precisely at the positive zero crossover of the 15-cycle fundamental and 135-cycle ninth harmonic, both being concident at zero degrees.

(b) The shore-based bearing servo system is similar to the shipboard beacon's bearing servo system referred to in paragraph 9 c (1) and figure 2-29.7, except that the shore antenna groups do not receive any ship's compass information. The bearing servo amplifier of the shore beacon contains only the magnetic variation servo loop. Fundamentally, the magnetic variation servo system of the shore-based beacon functions in the same manner as described for the shipboard beacon bearing servo system, except that the angular position signal received by the 1HCT's is generated by the magnetic variation subassembly only. The primary purpose of the magnetic variation subassembly is to maintain the 15-cps reference of the radio beacon in its correct position relative to magnetic north. As long as the rotors of the 1HCT's are oriented on the same angular position as that of the 1HDG's, no command is sent to the servo amplifier.

(c) For shore installation, jumpers have been added to terminal boards in the receiver-transmitter cabinet so that SELECT ANTENNA POSITION switch S606 on the coder-indicator is connected into the bearing servo system, thus serving a function different from the one it serves in shipboard installations. Normal operating conditions require the switch to be in its STOW position. In this position, the synchros (1HDG's) of the magnetic variation subassembly are

connected (with 78 volts between terminal 1 and jumpered terminals 2 and 3) to perform as generators.

(2) WARNING LIGHT. - The warning light system of the shore-based radio beacon operates in the same manner as described in paragraph 9 c (5) of this section, except that it will have only those relays associated with bearing and spin motor in series with the warning light (see figure 2-29.12).

f. BEARING MAGNETIC AMPLIFIER.

(1) GENERAL. - The block diagram of the bearing (azimuth) amplifier is shown in figure 2-29.20. Error voltages from the 1-speed and 36-speed synchro control transformers are fed to respective phase-sensitive detectors for comparison with the bearing reference voltage. Reference voltage is also fed to an isolation transformer and acts as the antistickoff voltage for the 1-speed error signal. The 1-speed phase detector output is a d-c voltage fed to a control winding of the amplifier through a de-emphasis network. The output of the 36-speed detector is fed to a separate control winding of the saturable reactor through a stabilizing network, as shown in figure 2-29.20. A stabilizing inductor is also shown coupled to the stabilization winding of the amplifier circuit. The amplifier output signal is the control voltage fed to the servo motor through the output transformer and power factor correction capacitor.

(2). PHASE-SENSITIVE DETECTORS, GENERAL THEORY.

(a) To detect a reversal in phase of an a-c signal, it is necessary to compare it to a fixed reference. A circuit which does this is shown in figure 2-29-21. The circuit operates as follows: With no error voltage present, assume a reference voltage is applied through T_1, causing point C to become positive with respect to point O. Points A and B are therefore positive with respect to O, and diodes 1 and 2 conduct by equal amounts. This results in equal voltage drops across R_1 and R_2, and the voltage across DE is zero.

(b) Assume an error voltage of the same frequency as the reference voltage is now applied across the transformer in phase with the voltage AO. The error voltage is now added to the reference voltage, the current through diode (1) increases, and voltage DO now exceeds EO. The error voltage at B is of a negative polarity and subtracts from reference voltage BO, reducing the current through diode (2). Since the voltage drop across R_1 is greater than the drop across R_2, D is positive with respect to E. If the error voltage is out of phase with the reference voltage, causing point B to become positive with respect to

to point A, the voltage drops across R_1 and R_2 will be reversed, as will the polarity of DE. The polarity of voltage DE changes with the polarity of the error signal, and the voltage is always proportional in magnitude to the error voltage.

(c) One other important feature of this phase-sensitive detector is that it will act as a limiter if the amplitude of the error voltage equals or exceeds the reference voltage. This occurs since the resultant voltage of path OCB in figure 2-29.21 will keep decreasing until the reference equals the error. Thereafter this voltage will increase again with the opposite phase. But since the diodes are insensitive to phase and are only affected by the magnitude of the voltage across them, the d-c rectified current no longer decreases but will increase for any further increase in error voltage. The difference between the resultants of paths OCA and OCB remains constant and is the net error voltage. By changing the magnitude of the reference voltage, it is possible to control the level at which the output dc from the phase-sensitive detector saturates. A curve of output dc as a function of a-c error voltage for various values of reference is shown in figure 2-29.22.

(d) The phase-sensitive detector of figure 2-29.20 has one important disadvantage, however, and that is that the fundamental (60 cycles in this case) appears across the load, since the output current is half-wave rectified. This difficulty is overcome by using full-wave rectifiers, as shown in figure 2-29.23. The circuit operation remains the same as that described for figure 2-29.23. On the positive half-cycle of the reference voltage, bridge rectifier 1 (CR2130 to CR2133) conducts while rectifier circuit 2 (CR2134 to CR2137) conducts on the second half-cycle. Each half-cycle then is characterized by one of the two circuits conducting.

(e) Since the rectifiers conduct by equal amounts, the voltage drops across the associated resistance are equal (since the resistances are of equal value), and the points between the upper and lower rectifier pairs will be at the potential of terminal D, the electrical center of the input circuit. If D is placed at ground potential, then points A and B will be at ground potential on alternate half-cycles. Assume that terminal 8 of transformer T2111 is positive and terminal 10 is negative, owing to the reference voltage present, causing bridge rectifier (1) to conduct. If the incoming error voltage is in phase with the reference voltage, causing terminal 3 to be negative and terminal 5 positive, and the polarity of the reference is maintained as before, then terminal C is

positive with respect to terminal D. However, if the error voltage is of opposite phase, so that terminal 3 is positive and 5 negative, while the reference voltage remains the same as before, then the voltage at terminal C will be the difference between the two voltages, and will be negative with respect to point D, and equal to one-half the voltage AB.

(f) The phase-sensitive detector output is a direct-current voltage proportional in magnitude to the a-c input signal and of a polarity depending on the polarity of the error voltage fed to it. The error output voltage is fed to the control panel.

(3) AMPLIFIER CIRCUIT. - The bearing magnetic amplifier utilizes two phase-sensitive detectors: one for the 1-speed error voltage and one for the 36-speed error voltage. Their reference windings are connected in parallel and their output signals are fed to respective control windings on the saturable reactor. The 1-speed transformer voltage is modified by adding to it the anti-stickoff voltage in the manner shown in figure 2-29.24, and discussed in paragraph 9 c (3).

(a) Figure 2-29.25 is a schematic diagram of the balanced bearing amplifier circuit, which provides power for the control phase of the bearing servo motor. Control of the servo motor is dependent on the error voltage from either the 1-speed or 36-speed synchro control transformer. This voltage, rectified in the phase detector, is fed to the amplifier through respective control windings of the saturable reactor. The magnitude of the error voltage is a function of the rate of change of the shaft position. If the error signal from the differential exceeds 2.5 volts, the equivalent to a shaft position 2.5 degrees away from null, the 1-speed transformer voltage takes control. For shaft positions less than 2.5 degrees away from null, equivalent to voltages below 2.5 volts, the controlling signal is the output of the 36-speed control transformer. De-emphasis network CR2146 (figure 2-87), in series with the 1-speed control winding, uses two rectifiers back to back in order to obtain a nonlinear, bilateral resistance. At low levels of current, the resistance of this circuit is high, owing to the characteristics of the diodes, and for high levels the resistance is decreased considerably. Thus when the 1-speed transformer error voltage is low, the gain of the 1-speed circuit is decreased. Conversely, when the error is large, the gain is increased and the 1-speed error voltage has a greater control, since the lowered resistance of the diode pair (CR2146) permits a much larger current to enter the control winding.

(b) When the 1-speed error is small, permitting the 36-speed transformer voltage to take control, it becomes necessary to de-emphasize the 1-speed error voltage, since its presence in the control winding would introduce some error into the system. The parallel arrangement of R2151 and C2113, placed in series with the 36-speed control winding, is an equalizing network commonly used in servo work as a means of reducing the steady state following error. Stabilizing inductor (L2112) is inserted in the saturable reactor circuit to provide a more stable reactor circuit operation.

(c) The series rectifiers (CR2126, CR2127 and CR2128, CR2129) in each branch of the balanced amplifier circuit are intended to keep the load current in the branch from reversing. The circuit is said to be balanced, since the center tap of output transformer T2109 is at the electrical center of each branch of the circuit. Parallel resistances R2148, R2155 and R2149, R2156 across the load windings are for balancing the a-c output. The value of resistance is chosen to give zero a-c voltage output for zero d-c current in the control windings. The value of the resistors also determines the correct bias current in the load windings.

(d) The operation of the amplifier is as follows: Assume there is an error voltage which tends to saturate the core of branch A, and desaturate the core of branch B. In other words, the flux of branch A is in opposition to the flux of branch B. This condition unbalances the circuit, resulting in current flow in the load windings of the saturated branch only. If the polarity of the error voltage is reversed, branch B is now saturated, while branch A is now desaturated. Now current flow is in the load windings of branch B. It is seen that the load current reverses direction with the reversal of error voltage. The load current circulates through branch A or B of the amplifier, to the center tap of the output transformer, then to the load.

g. SERVO MOTOR.

(1) The servo motor, which constitutes the amplifier load, is a two-phase induction-motor type, having a continuously excited phase and a variable phase The output torque of the motor is roughly proportional to the current delivered by the amplifier a-c windings, and the direction of torque is determined by the polarity of the control voltage.

(2) Blowers are connected to the pitch and roll motors to help dissipate the heat generated in the units. Brake solenoids are part of the apparatus, and serve to lock the position of the antenna in pitch and roll when the equipment is

de-energized. The bubble canopy (radome), which protects the antenna and pedestal from weather, also serves to decrease wind resistance. Without the bubble canopy, larger servo motors would be required.

(3) The fixed voltage winding of the motor is excited from the supply source through phase-shift capacitor C2112 (figure 2-29.25). The capacitor causes a shift in phase of approximately 90°. The control phase of the motor is coupled to one side of the output transformer (T2109) through a 4-μf capacitor (C2111). This capacitor tunes out the inductance of the magnetic amplifier and the motor windings. The other side of the output transformer is connected to the motor common terminal.

h. ANTENNA SPEED CONTROL (SHORE).

(1) GENERAL. - As discussed previously, the speed of the rotating cylinders carrying the parasitic reflectors must be a constant 900 rpm, this speed determining the modulation frequencies. To control this speed, a tachometer and speed control system are employed. The tachometer will put out 675 cycles per second when the antenna cylinders are spinning at the required 900 rpm.

The speed control amplifier consists essentially of a preamplifier and a power amplifier. The preamplifier (see figure 2-29.26) circuit consists of a phase-sensitive detector (frequency discriminator), an oven control amplifier, and a voltage amplifier with related circuits. The power amplifier (see figure 2-29.27) consists of three saturable reactors with associated rectifier circuits and transformers. The phase-sensitive detector (see figure 2-29.28) senses any deviation in the tachometer frequency from the norm of 675 cycles per second and produces an error voltage proportional in magnitude to the frequency deviation. This voltage is amplified in the speed control preamplifier and fed to the power amplifier, which directly controls the speed of the spin motor.

(2) PREAMPLIFIER CIRCUIT. (See figure 2-29.29.)

(a) FUNCTIONAL DESCRIPTION. - The voltage developed by the tachometer is fed to the primary of the phase-sensitive detector transformer, which has two secondary windings. The output from a secondary winding is fed to one set of arms of the rectifier unit, and the output from the other secondary winding is fed to the other set of arms through a tuned circuit in the reference unit. If the tachometer frequency is the same as the tuned circuit (675 cps), the two voltages across the rectifier arms will be in phase and no error voltage is developed. However, if the tachometer frequency varies from the norm, the output from the tuned reference unit will be out of phase with the voltage across the other rectifier arms, and the phase difference between the two voltages will be proportional to the frequency deviation, and to the error voltage.

The error voltage at the output of the phase detector rectifier unit is fed to a front panel indicator and to a voltage amplifier through an equalizing network. A separate amplifier used for controlling the oven senses any change in the oven temperature and operates a relay that controls the heating elements in the oven. The function of the oven is to keep the frequency of the tuned circuit in the reference unit from drifting. Direct current for the heat control elements is supplied by a bridge rectifier, which also supplies d-c bias for the voltage amplifier.

(b) CIRCUIT DESCRIPTION.

1. PHASE-SENSITIVE DETECTOR. - The phase-sensitive detector circuit (see figure 2-29.29) is essentially the same as that discussed in paragraph 9 f (2) (d) and illustrated in figure 2-29.23. Any deviation in tachometer frequency from the norm of 675 cps is sensed by the detector, which develops an error voltage proportional to the frequency deviation. This is accomplished as follows: If the incoming tachometer signal frequency is 675 cycles per second, the resonant frequency of the tuned circuit consisting of C2103 and the primary of reference transformer T2101, the circuit will be wholly resistive at resonance and no phase shift is produced. This results in zero error voltage. If the tachometer frequency is above that of the resonant circuit, the circuit acts as an inductance, causing a current lag proportional to the frequency difference. If the incoming frequency is below the norm, the circuit has a capacitive effect on the signal with oppositive (or leading) phase difference. When this leading or lagging voltage is compared by the detector with the reference voltage across the direct secondary winding, an error voltage is developed.

2. OVEN CONTROL AMPLIFIER. - Primary function of the oven amplifier (figure 2-29.30) is to control the temperature of the oven used to maintain a fixed resonant frequency in the reference unit. The amplifier translates oven temperature changes to corresponding signal voltages that operate oven relay K2104 through which the heaters are energized. A d-c control current for the amplifier is developed in the bridge circuit (figure 2-29.31). Resistances R2 and R3 are the oven temperature control elements. The bridge is adjusted by means of potentiometer R2107 to establish the proper level of quiescent current to operate the relay within the oven temperature limits.

Should ambient temperature conditions cause any increase in oven temperature beyond the established limits, the resistance of control element R3 increases,

tending to balance the bridge and resulting in a reduction in the current through the amplifier control winding. A decrease in current de-energizes the heater elements by causing the relay to be tripped to the open position. The oven temperature now falls below normal, resulting in a rapid decrease in the resistance of R2, causing an unbalance in the bridge circuit in a direction that reverses the current flow. As the oven cools further, the control current increases sufficiently to trip the relay to its closed position. Actually, the relay is constantly opening and closing at intervals determined by ambient temperature changes.

Diodes CR3 and CR4 (see figure 2-29.30) are used to provide the d-c bias current. CR1 and CR2 supply a full-wave rectified output that is proportional to the a-c load current, and hence serves as a positive feedback through R2108. Positive feedback increases the response of the amplifier to relatively small changes in control current. The rectifiers also serve to reduce the a-c voltage induced in the control circuit.

3. VOLTAGE AMPLIFIER. - The voltage magnetic amplifier (figure 2-30.1) receives the speed error voltage developed in the phase-sensitive detector circuit, amplifies it, and converts it to an equivalent d-c component.

Output error voltage from the phase-sensitive detector is applied to the amplifier control winding through a phase advance network consisting of R2112 and C2101. This network stabilizes the operation of the amplifier by removing ripples from the error signal, preventing the amplifier from saturating because of noise voltages.

L2102 is a stabilizing inductor placed in the circuit to filter out variations in the reactor magnetic field. Rectifier CR2109 establishes the d-c bias voltage regulated by the setting of potentiometer R2111 which establishes the d-c saturation flux. Error voltage in the reactor a-c windings is converted to a proportional d-c component by a phase-sensitive rectifier, CR3 through CR6, and appears as the output control signal. This signal is fed to the control winding of the power amplifier that controls the antenna spin motor. A portion of the d-c signal voltage is also fed to the reactor feedback winding, to increase the amplifier gain, which is determined by the setting of gain control potentiometer R2117.

4. POWER AMPLIFIER. - The function of the power amplifier (see figure 2-30.2) is to control the amplitude of the three-phase power input to the antenna spin motor and thereby control the speed of antenna rotation. The

control current is developed in the preamplifier circuit and is fed directly to the control windings of the power amplifier.

The output saturable reactors, L2106, L2107 and L2108, are each in series with one phase of the three-phase power line. The line current to the spin motor is controlled by the impedance of these reactors. Thus for low values of d-c control current the saturation is low, resulting in a high impedance. The motor voltage is decreased and the motor slows down. Conversely, for large values of control current, the motor voltages will be increased owing to the lower reactor impedance, and the motor will then speed up.

The reactors have bias windings that are shunted by single rectifiers as illustrated in figure 2-30.2. The purpose of these rectifiers is to suppress harmonics of the line frequency that are induced in the control and bias windings of the reactors. Full-wave rectifier CR2120 produces the bias current by utilizing one phase of the 208-volt line in conjunction with the current limiting resistors R2134, R2133, and R2132. Bias for the individual reactors is set by potentiometers R2129, R2130 and R2131. Resistances R2126, R2127 and R2128 are load resistances.

To correct the power factor of the spin motor voltage, three power factor correction circuits in a wye connection are provided. Ordinarily, only capacitors would be required, but since the amount of capacity necessary would make the equipment too large, an autotransformer is provided. This autotransformer effectively multiplies the capacity by the turns ratio squared of the autotransformer.

Although the rectifier limits the current in the proper winding to that which will flow during only one of the two half-cycles of the ac, it causes a d-c component of current to flow in the power winding. This d-c component is proportional to the a-c load current, and hence serves as a positive feedback, reducing the amount of current required to control the reactor to a rather small value.

i. ROLL AND PITCH MAGNETIC AMPLIFIER.

(1) The roll and pitch magnetic amplifiers are almost identical units. Accordingly, the following discussion applies, except as noted, to both. The essential components of the amplifier (see figure 2-30.3) are a phase-sensitive detector, electrical damping and acceleration feed-back circuits, preamplifier, and power output amplifier.

The synchro error voltage from the roll or pitch control transformer is fed to the phase-sensitive detector circuit (see figure 2-30.4). The circuit functions

exactly as described in paragraph 9 f (2) (d) under magnetic amplifier theory Reference voltage for phase-detector transformer T2025 is tapped from the 115-volt, 60-cycle synchro bus.

(2) The d-c output from the phase detector is the control current for the preamplifier illustrated in figure 2-30.5. The control current passes through three pairs of control windings that are connected in series aiding, while the tachometer feedback current is fed through only two of these same windings in series. Isolation of these two circuits is obtained by the impedance of capacitors C2022 and C2023 shunted across potentiometer R2032 used as a damping control, and C2024 and C2025 in the same circuit. Resistor R2036 in the control current circuit also serves to isolate the two signals. The gain of each amplifier is preset at the factory as required for each unit. The isolation impedance in the tachometer circuit serves the purpose of changing the tachometer voltage from rate feedback to acceleration feedback. This helps to stabilize the servo system.

(3) To provide further stabilization and to improve the balance of the amplifier, a portion of the load current is fed back out of phase to the primary of phase-detector transformer T2025 through the feedback windings and limiting resistor R2041. (See figure 2-30.6.) The negative feedback also acts to prevent the servo motor from single-phasing, resulting in a smoother overall performance of the system. D-c bias current for the magnetic preamplifier (figure 2-30.6) is obtained from the bridge rectifiers CR2029 through CR2032. Resistors R2027 and R2028 in parallel are current-limiting resistances while R2025 and R2026 are balancing resistors. The output of the magnetic amplifier is obtained from two a-c windings. The current from each winding is bridge-rectified by CR2035 through CR2042 and is used for both positive feedback and as control and bias current for the next amplifier stage.

(4) Saturable reactor L2022 (figure 2-30.7), feedback rectifiers CR2045 through CR2052, and power transformer T2024 comprise the power magnetic amplifier, the output of which controls the roll and pitch servo motors. The operation of the power amplifier is essentially the same as that of the preamplifier described previously.

j. ANTENNA SERVOS METER. - An ANTENNA SERVOS meter (error indicator) is mounted on the front panel of the coder-indicator. A METER SELECTOR switch is provided below the meter and permits the operator to check the operating condition of the antenna servos as well as the antenna speed of rotation.

This is accomplished by rotating the METER SELECTOR switch to the position corresponding to the circuit to be checked. The switch positions are AZIMUTH, SPEED PITCH and ROLL. The dial of the ANTENNA SERVOS meter, which is zero-centered, is divided into green and red sectors. A deflection of the pointer into the red sector is indicative of malfunctioning of the circuit being tested. Excessive oscillation or overtravel of the pointer also indicates a faulty system.

k. ANTENNA ERECTION.

(1) An erection switch, S606 (see figure 2-30.8), is located on the front panel of the coder-indicator to stabilize the antenna in a position normal to the deck, which is desirable in rough seas, and for antenna servicing. This switch, a two-position switch labeled STOW-STABILIZED, is left in the stabilized position during normal operation. Throwing the switch to STOW erects the antenna perpendicular to the deck, and eliminates tracking of roll and pitch. The antenna should be erected before shutting down the equipment.

(2) Erection of the antenna is accomplished by placing 78 volts across terminals S2 and connected terminals S1, S3 of the stator winding of the roll and pitch control transformers. This is accomplished as shown in figure 2-30.8. Note that the 78 volts is obtained from tapped transformer T603 whose input is derived from the pitch and roll reference voltage. Switching occurs across erection switch S606, which is a two-position, ganged-wafer switch. In the STABILIZED position, the roll and pitch error signals developed within the ship's vertical gyro are applied to the roll and pitch control transformer. Thus tracking of ship's roll and pitch is accomplished. With the erection switch thrown to STOW, terminals S1 and S3 of the roll and pitch control transformer are jumped and 78 volts from the transformer T603 applied across terminals S2 and connected terminals S1, S3. The antenna is now erected to a position perpendicular to the deck. (For a further discussion on vertical erection with synchros see United States Navy Synchros, Description and Operation, Ordnance Pamphlet No. 1303.)

10. POWER SUPPLIES CIRCUIT ANALYSIS.

a. RECEIVER POWER SUPPLY. - The receiver power supply, figure 2-31, provides regulated -105 volts dc for the video amplifier stages and regulated B+, 150 volts dc, for the complete receiver. The B+ supply is regulated by V503, V504, and V505. The -105-volt supply is regulated by V506.

Gas diode V505 provides a fixed negative bias for control V504. The voltage on the grid of V504 is set by the voltage divider R506, R507, R508 at a fixed fraction of the voltages between B+ and -105 volts. The voltage drop across the plate resistor R505 is the bias voltage for the regulator tube V503. If the B+ voltage remains constant, the voltage on the grid of V504 does not change, and therefore the bias voltage for V503 remains constant. The voltage at the cathode of V503, because of the voltage drop across the tube, is therefore 150 volts. If this voltage drops, the bias of V504 increases; the drop in plate current causes the voltage at the plate of V504 to become more positive; the bias of V503 therefore decreases, causing a drop in the resistance of this tube, and the B+ voltage at the cathode of V503 increases, counteracting the original drop in voltage. Increases in the B+ voltage are counteracted by the same principle of the variable resistance of V503.

b. CODER-INDICATOR POWER SUPPLY. - The power supply for the coder-indicator employs a single power transformer for both the plate and bias voltages. Stage V701 constitutes a full-wave rectifier for the plate supply voltages.

The filter circuit of the plate supply is of the choke input type consisting of choke L701 and shunting filter capacitor C701. This type of filter network has been selected because it subjects the rectifier to less peak inverse voltage.

The voltage regulator circuit uses the familiar combination of regulator tube and control tube. This regulator circuit produces an output voltage which is independent of fluctuations in the a-c supply and charges in load over a wide range. The output voltage is developed across R708, R710 and R711 in parallel with the effective load resistance. The other resistance, through which all the load current must flow, is the plate to cathode resistance of vacuum tube V703. The other elements in the circuit are used to control the resistance of V703 and thereby maintain a constant voltage across the load.

The cathode voltage of V703 is the regulated output voltage. The cathode potential of V703 is held at a constant positive value by grid biasing through potentiometer R710 and V627, an OB2 glow tube. Grid potential is set through R710. This potentiometer is set so that the grid voltage is slightly negative by an amount (the bias) which causes V704 to pass a certain plate current. The magnitude of the voltages across resistors R703, R704 and R705 is the bias on tube V703. Therefore the adjustment of potentiometer R710 establishes the normal resistance of V703. This adjustment is used to set the value of load voltage which the regulator is to maintain.

If the load voltage tends to rise, whether from a decrease in the load current or from an increase in the input voltage, the voltage on the grid of V704 also tends to rise (become less negative). V704 then conducts more current because the bias is smaller. A greater current flows through R705 which causes a greater voltage drop across it. This voltage which is the bias voltage for V703 causes the plate resistance of V703 to increase. A larger portion of the available voltage appears across the high resistance of V703, and the load voltage remains practically constant. If the load voltage tends to fall, the voltage on the grid of V704 also tends to fall (becomes more negative). V704 then conducts less, a smaller current flows through R705 which causes a smaller voltage drop across it. This bias voltage for V703 causes the plate resistance of V703 to decrease. A smaller portion of the available voltage appears across V703, and the load voltage remains constant.

Bias voltage is obtained from an independent secondary winding on transformer T702. Stage V702 is used as a full-wave rectifier. A T-connected RC network is used for both filtering and for current limiting the gas regulator tube V705. A bias voltage of 108 volts results. Capacitor C703 is made large enough to have low impedance to the ripple frequency. The d-c component of the voltage sees an infinite impedance looking into C703. The d-c component therefore drives a current through the paralleledresistances R714 and R715.

Warning light DS701 is prominently displayed on the chassis and serves to warn the technician when the interlock is shorted and voltage is still applied to the power supply.

c. TRANSMITTER LOW-VOLTAGE POWER SUPPLY. - The low-voltage power supply unit contains two familiar-type full-wave rectifiers employing 5R4WGB tubes. The rectifier plate transformers are connected to the 120-volt single-phase power by the contactor, K1603. This contactor is operated by the control circuit. The red indicator light I1603 is lit when the rectifier plate transformers are energized. Simple capacitor input filters are connected in the two unregulated d-c output circuits of the rectifiers. Two series-type voltage regulators are used. The two regulators are essentially the same, differing only in the values of some of the resistors and the number of series tubes connected in parallel. Capacitor filters are connected in the output circuits of the regulators.

The magnetic relay (K1601) is connected across the -375-volt output. One set of contacts on the relay is connected in series with the control circuit to prevent the medium-voltage power supply from functioning unless the -375-volt

output is available. Another set of contacts on the relay closes the circuit of the green indicating lamp, DS1601, when the -375-volt output is present.

The two series regulators of the low-voltage power supply are essentially the same. One discussion covers both. The output voltage of the regulator is the difference between the input voltage of the regulator (the output voltage of the rectifier filter section) and the voltage drop of the series tube V1611. Voltage regulation is accomplished in the following manner:

The regulator tube V1613 supplies the grid "7" of V1612 with a constant bias. The cathode "8" voltage is obtained from the divider network consisting of R1663, R1664, R1665, R1669 and R1666. If the load increases and the output voltage drops, the cathode "8" voltage will decrease proportionately and more current will be drawn by the tube. More current will flow through plate resistor R1662 which causes a greater voltage drop across it. The increased voltage drop across R1662 raises the grid "2" bias of the left triode of V1612 and consequently raises the voltage on the grids "2" and "6" of V1611. This effectively reduces the impedance of V1611 and hence the voltage drop across the tube, which results in restoring the output voltage to normal. Similarly, if the output voltage tends to rise due to a decrease in the load or an increase in the input voltage from the rectifier, the impedance of V1611 will be increased, causing a greater voltage drop across it, and hence reducing the output voltage to normal.

The capacitors C1612, C1613, and C1623 enable the ripple voltage to appear between the grid and the cathode of amplifier tube V1612 and thus provide a ripple attenuation factor in the regulator. The resistors in the plates, screen grids, and control grids circuits of the series tube are parasitic suppressors.

A voltmeter on the front panel of the frequency multiplier-oscillator chassis indicates the output of the low-voltage power supply.

d. TRANSMITTER MEDIUM-VOLTAGE POWER SUPPLY. - The medium-voltage power supply contains one full-wave rectifier employing two 836 tubes. The rectifier plate transformer T1801 primary is connected to the incoming 120-volt, single-phase power by the contactor K1804. The contactor is operated by the control circuit. A simple capacitor input filter is connected in the unregulated rectifier output circuit. A series-type regulator, figure 2-32, is connected in the filter output circuit to provide the 1,000-volt output. The 1,000-volt series-type regulator uses five series tubes (829B) in parallel. A capacitor filter (C1801) is connected in the 1,000-volt output circuit of the voltage

regulator. A positive 700 volts is obtained by voltage dropping across series resistors R1875 and R1876 connected to the 1,000-volt regulated output bus.

The medium-voltage supply contains an overload relay (K1805). When an excessive current is sustained, the overload relay functions to disconnect the plate voltage. Very brief transients do not trip the overload relay. This time delay feature is necessary so that large charging currents that occur when the equipment is started do not trip the overload relay.

The relay K1801 is connected across the 1,000-volt regulated output. When the coil is energized, the contacts of the relay make and activate the red indicating lamp, DS1801, which is located on the front panel of the medium-voltage power supply unit.

The 1,000-volt output is regulated by five series tubes connected in parallel. The corrective grid "6" bias is obtained in the following manner (figure 2-32): The plate "1" voltage of V1808 is the output voltage of the regulator. The cathode "3" is kept at a constant potential by the regulator tube V1810 through V1814. The grid "2" bias is obtained from the divider network consisting of R1846, R1842 and R1850. Potentiometer R1842 makes it possible to set the initial bias at the proper bias for the desired output voltage. If the load increases the regulator input voltage tends to decrease due to the voltage drop in the rectifier. The voltage drop in the divider network decreases and with it the bias on grid "2" of V1808, resulting in a reduction in the plate current of this tube. The reduced plate current decreases the voltage drop in R1845 and consequently reduces the bias on the series tubes V1803 through V1807, thereby lowering impedance. The reduced drop in V1803 through V1807 compensates for the increased load voltage drop and the output voltage is restored to normal. An increase in input voltage to the regulator would act in an opposite manner to increase the impedance of tubes V1803 through V1807.

The resistors in the plate, screen grid and control grid circuits of the series tubes are parasitic suppressors.

The output of the medium-voltage supply is indicated on a voltmeter on the front panel of the frequency multiplier- oscillator chassis.

The transmitter medium-voltage power supply contains overload relays so that in the case of an overload the incoming power supply from the medium-voltage power supply plate transformer primary is disconnected. The operating point of the time delay relay K1803 circuit is set by variable resistor R1872. When an overload is sustained long enough to actuate the relay K1803, contacts

3 and 4 make, energizing the coil of the magnetic relay K1802. Relay K1802 contacts 3 and 4 make, contacts 5 and 6 make, and contacts 7 and 8 break. The make 3 and 4 contacts of relay K1802 keep relay K1802 energized after contacts 3 and 4 of relay K1803 reopen. When contacts 7 and 8 of relay K1802 open, the holding coil of K1804 (the medium-voltage power supply plate contactor) is de-energized and the medium-voltage power supply is disconnected. When contacts 5 and 6 of relay K1802 make, the motor of the motor-driven reclosing relay K1805 is energized. Three seconds later contact B of K1805 swings monentarily to the number 6 position (120 volts ac), energizing resetting relay K1806. All the contacts of K1806 break. When contacts T3 and L3 of K1806 break, the path holding relay K1802 energized is broken, and relay K1802 is de-energized. Contacts 7 and 8 of relay K1802 close, energizing relay K1804, thus restoring the equipment to normal operation. Overload reclose relay K1805 will swing contact A to the number five position (120 volts ac) three times in case of a continuous overload or successive trips occurring less than 1.2 seconds after the preceding reclosure; then contact C will open and contact A will close (number 4 position), breaking the overload reset relay K1806 circuit, shutting down the equipment. The equipment will remain shut down until S1802 is manually closed (S1802 must be held closed; it returns to the open position if not held closed). The closing of S1802 closes contacts A (number 5 position) and C of K1805. If the overload trips occur 1.2 seconds or later after each previous reclosing K1805 will continue to reclose automatically.

e. HIGH VOLTAGE POWER SUPPLY PP-1764/URN. (See figure 2-39.) - The high-voltage power supply contains a three-phase, full-wave rectifier employing 8020 tubes. The 9,220-volt plate power is supplied by the transformer T1001, which is mounted separately in the power supply and test set cabinet. A simple capacitor filter is connected in the 12,000-volt rectifier output circuit. The high-voltage power supply does not use a voltage regulator. The 12-kv supervisory relay K1801 is connected across part of the filter bleeder circuit and is thus energized by the 12,000-volt output. A variable resistor in series with the coil makes it possible to adjust the voltage across the coil to a suitable value. The contacts of the relay close to allow application of screen voltage to tube V1302 in the transmitter only after the high voltage has reached approximately 10 kv.

The elapsed time indicator M1901 on the front of the high-voltage power supply unit operates when the plate contactor is closed and power is supplied to the

unit. Thus it records the total time that the 12,000 volts dc has been supplied to the klystron. The red indicating light, DS1901, is in parallel with the elapsed time indicator just described and warns the operator that the 12,000-volt output is present. Another elapsed time indicator, M1901, records the total time that the high-voltage power supply filament transformer is energized, and also the time that power is supplied to other filaments of the transmitter. A protective switch is provided on the high-voltage power supply drawer that shorts, through a resistor, the 12,000-volt output and discharges the filter capacitors whenever the unit is pulled out.

A voltmeter on the front panel of the amplifier-modulator chassis indicates the output of the high-voltage supply.

Potentiometer R1909 provides a means of adjusting the operating point of relay K1901 with respect to the high-voltage power supply output voltage.

The contacts of relay K1901 close when the output voltage of the high-voltage power supply exceeds approximately 10 kv, and power is applied through these contacts to the coil of relay K1302, which in turn controls the application of power to the screen of V1302 in the amplifier-modulator. In this manner the screen of V1302 is protected in case of failure of the high-voltage power supply.

Relay K1904, in series with R1911, R1912 and contacts 3 and 4 of relay K1905, is connected in parallel with resistor R1906 which is in the return path for the total output current of the high-voltage power supply. A portion of the output current will be shunted through the coil of K1904, depending on the setting of variable resistor R1912. With resistor R1912 properly adjusted, relay K1904 will close when the current drain on the high-voltage power supply exceeds approximately 200 ma. When relay K1904 closes, power is applied to the coil of the overload auxiliary relay K1902, and the high-voltage plate supply is switched off subject to automatic resetting as described under paragraph d on the medium-voltage power supply.

When the high-voltage power supply is first energized, there is a momentary surge of current as the filter capacitors C1901 and C1902 are charged to 12 kv. This surge of current flows through R1906 and would cause relay K1904 to close except for the fact that the contacts of K1905, which are in series with the coil of K1904, are open during the time capacitors C1901 and C1902 are charging. Relay K1905 does not close immediately after power is applied to the high-voltage power supply, but is delayed in closing until capacitor C1904 charges through resistor R1914. This delay is sufficient to allow the power supply filter

capacitors to charge, thereby preventing the current overload relay K1904 from tripping on the initial starting surge of current.

f. HIGH VOLTAGE POWER SUPPLY PP-1763/URN. (Refer to figure 2-40.). High Voltage Power Supply PP-1763/URN is similar to High Power Supply PP-1764/URN with the following exceptions:

(1) The positive side of the power supply output is grounded through the CHARGING CURRENT meter on the front panel of the amplifier-modulator chassis, and negative side of the power supply is 12 kv above ground. Output voltage from the high-voltage power supply is fed through intercabinet cabling and applied directly to the klystron cathode as a negative potential of 12 kv which establishes the required accelerating potential between the klystron cathode and plate. Resistor R1918, which is connected between the positive side of the high-voltage power supply and chassis ground, is a thyrite resistor which provides a path to ground for the positive side of the high-voltage power supply in case an open occurs in the circuit from the positive side of the power supply through the CHARGING CURRENT meter to ground.

(2) There is no 12-kv supervisory relay that opens in the event that the high-voltage power supply drops below 10 kv. As the amplifier-modulator associated with High Voltage Power Supply PP-1763/URN does not contain a type 4-1000-A tube, it is not necessary to include an output voltage supervisory relay in the power supply.

(3) Power supply filter capacitors C1901 and C1902 are mounted above ground and connected directly across the output of the high-voltage rectifiers. Therefore, the initial surge of charging current to the power supply filter capacitors does not pass through overload relay K1904 and shunting resistor R1906, and it is not necessary to add a relay to disconnect the overload relay during the initial charging of the power supply filter capacitors.

11. POWER DISTRIBUTION AND CONTROL CIRCUIT ANALYSIS.

a. The functioning of the power distribution and control circuits is described below, with reference to the power distribution diagrams included in Section 7. All controls are in the off position.

b. When EMERGENCY SWITCH S901, mounted on the receiver-transmitter cabinet, is closed, these things happen:

(1) The line power is connected to the antenna motor contactor.

(2) Power (208-volt, three-phase, 60-cycle) is connected to the terminals of main contactor K1101 and blower contactor K1103.

(3) Power (120-volt, single-phase, 60-cycle) is connected to the crystal oven transformer in the frequency multiplier-oscillator drawer. This power may be obtained from the convenience outlet circuit.

c. When MASTER SWITCH S1101 on the control panel is set to STANDBY, the following occurs: Primary contactor K1101 closes, connecting 208-volt, three-phase, 60-cycle power to the terminals of high-voltage plate contactor K1001, and 120-volt, single-phase, 60-cycle power to FIL ON switch S1108, the low-end medium-voltage plate contactors, K1603, K1604 and K1804, the control circuit bus, the antenna control switch, the test set switch, coder-indicator switch S601, receiver switch S502, MAIN POWER indicating light DS1102, and the coil of blower contactor K1103.

d. Blower contactor K1103 closes, connecting main cabinet blowers B901, B902 and B1001 to the 208-volt, three-phase, 60-cycle power. When the power is shut off by the master switch, the blower contactor is kept closed by time delay relay K1102 for one minute after primary contactor K1101 has opened so that the equipment will not be damaged by excessive temperature and the heat stored in the hottest part of the equipment will be dissipated rapidly.

CAUTION

The equipment must not be shut down by EMERGENCY SWITCH S901 until one minute has elapsed after returning the master switch to OFF.

e. The following switches may now be closed:

(1) ANTENNA ON S1102, energizing the antenna control circuit. If the spin motor switch on the antenna control is closed, the antenna spin motor will rotate.

(2) CODER-INDICATOR ON S1104, energizing the coder-indicator circuit.

(3) TEST SET ON S1103, energizing the test set circuit.

(4) RECEIVER ON S1105, energizing the receiver circuit.

(5) FIL ON S1108, energizing the filament transformer circuits and the FIL white indicating light, DS1105. The ADJUST FOR 120V knob on the control panel operates the filament voltage adjusting transformers, T1101 and T1102. Ordinarily the SUPPLY VOLTS voltmeter, M1101, is connected to the adjusted filament transformer voltage by meter switch S1106. This meter may also be used to check the unregulated voltage by connecting it to the line by the meter switch. When the FIL ON switch is closed, the filament transformers of the low-, medium- and high-voltage power supplies, filament transformers

T1501 and T1403 in the frequency multiplier-oscillator, and filament transformer T1350 in the amplifier-modulator are immediately energized. Relay K1401 energizes time-delay relay K1605, which prevents the low- and medium-voltage power supply plate voltages from being applied until the filaments have been connected for one minute. Filament transformers T1301 and T1303 and white indicating light I1301 in the amplifier-modulator are energized through relay K1301. Simultaneously time delay relay K1106 is energized, providing a five-minute delay before the high-voltage power supply plates (and, indirectly, the klystron) can be energized.

f. With the master switch at STANDBY, the equipment will remain in the condition just described indefinitely.

g. With the master switch set to ON, the drawer interlocks are connected to the 120-volt a-c control power. The low-voltage power supply is ready to be activated if:

(1) The drawer and compartment covers are in place, or the INTERLOCKS SHORTED switch is closed, which is done only in extreme emergencies, or the individual interlocks have been manually closed, as may be the case during tuning procedures.

(2) The one-minute time delay relay, K1605, is closed.

(3) The blue light LV MV READY is lit.

h. If the master switch is set to ON without stopping at STANDBY, the equipment will arrive at operating condition after the various time delays have been completed.

i. TRANSMITTER LV ON switch S1601 may now be closed. This energizes low-voltage plate contactor K1603, causing the low-voltage power supply to function. Medium-voltage power supply plate contactor K1804 will close, energizing that unit if the following conditions exist:

(1) Relay K1601 is energized by the -375-volt d-c output of the low-voltage power supply.

(2) Medium-voltage overload relay K1802 is de-energized.

(3) Overload reset relay K1806 is de-energized.

(4) TRANSMITTER MV ON switch S1801 has been turned on by the operator.

j. The d-c output of the medium-voltage power supply closes screen supervisoy relay K1801, which connects +300 volts dc, obtained from the low-voltage power supply, to the screens of the tubes in the frequency multiplier-oscillator.

k. The high-voltage power supply plate contactor, K1001, will close, connecting 208-volt, three-phase, 60-cycle power to the primary of plate transformer T1001 if the following conditions exist:

(1) Relay K1804, the plate contactor of the medium-voltage power supply, is energized.

(2) The contacts of five-minute time delay relay K1606 are closed. This relay is energized at the same time as filament transformer T1303, which heats the filaments of the klystron and tube V1301 and T1301, which heats the filaments of tubes V1302 and V1303.

(3) Blue indicating light DS1802 shown READY FOR 12 KV, signifying that conditions (1) and (2) above have been met.

(4) Overload relay K1902, in the high-voltage power supply drawer, is de-energized.

(5) TRANSMITTER HV ON switch S1111 is set to ON.

l. The high-voltage d-c output energizes V1302 supervisory relay, K1901, in the high-voltage power supply drawer, which in turn energizes the V1302 screen relay, K1302, in the amplifier-modulator drawer, with power obtained from the 120-volt a-c control circuit bus. This latter relay connects +700 volts dc, obtained from the medium-voltage power supply, to the V1302 tube screen.

m. Additional information on the normal functioning of the control and power distribution circuits is presented in the paragraphs below.

(1) All the ON switches on the control panel may be closed before the master switch is advanced to STANDBY or ON.

(2) If the master switch is moved to ON, all ON switches being closed, the equipment will be automatically energized in its proper sequence, a period of five minutes being required before it is fully energized.

(3) Once the equipment has been fully energized, all ON switches remaining closed, the master switch may be moved back to STANDBY, then returned to ON, and the equipment will then be immediately fully energized. The equipment may therefore be left in the STANDBY position when not required to send or receive information.

(4) If the high-voltage power supply unit or the amplifier-modulator unit is pulled out or the transformer and blower compartment panel is removed, the high-voltage power supply will be disconnected, but the low- and medium-voltage power supplies will remain functioning. If the low- and medium-voltage

power supply units, the receiver unit, and the frequency multiplier-oscillator unit are pulled out, the low-, medium- and high-voltage power supplies will be disconnected.

(5) Overload protection is provided for the medium- and high-voltage power supplies. An overload in the medium-voltage power supply disconnects that unit and also the high-voltage power supply, An overload in the high-voltage power supply disconnects only the high-voltage power supply. An automatic reclosing relay K1805, restores the power through resetting relay K1806 after three seconds. The automatic relay will reset three times and then shut down until reset manually by reset switch S1802. In either case, if the cause of the overload has not been removed, the overload relay will trip again.

(6) INTERLOCKS SHORTED switch S1107, used only in emergencies, in addition to shorting the drawer interlocks of the control circuit, shorts the unit interlocks on the receiver and on the coder-indicator, thereby connecting the 120-volt a-c input to the individual power supplies.

The individual unit interlocks may be closed manually with the unit pulled out when it is necessary for tuning. Units in which high voltage is exposed have additional contacts in the interlocks which connect the red warning light. Interlocks closed in this manner are restored to normal functioning when the unit is closed.

(7) The equipment may be energized by a remote control switch if all the ON switches on the control panel are closed and the master switch has been turned to REMOTE CONTROL. A white indicating light on the remote control switch shows that it is ready for use. The remote control switch has OFF, STANDBY and ON positions that perform the same functions as positions with the identical designations on the MASTER SWITCH. There are two red indicating lights on the remote control unit; one tells when the low-voltage power supply and the medium-voltage power supply are ready for energizing, and the other shows that the high-voltage power supply is ON.

12. BUILT-IN TEST EQUIPMENT.

a. GENERAL. - The test equipment is provided to permit rapid check of the important operating characteristics of the radio beacon. The test equipment provided includes the following five units:

(1) Pulse-Sweep Generator SG-121A/URN-3 (Technical Manual NAVSHIPS 92745).

(2) Pulse Analyzer-Signal Generator TS-890/URN-3 (Technical Manual NAVSHIPS 92819).

(3) Power Meter-Pulse Counter TS-891/URN-3 (Technical Manual NAVSHIPS 92809).

(4) Oscilloscope OS-54/URN-3 (Technical Manual NAVSHIPS 92778).

(5) Switch-Test Adapter SA-420/URN-3 (Technical Manual NAVSHIPS 92809).

The first four units are mounted in compartments of Power Supply Assembly OA-500/URN-3, above the low-voltage power supply. The location of Switch-Test Adapter SA-420/URN-3 is optional. However, it should be located so that lengths of cables connecting it to the rest of the equipment are kept to a minimum.

The units are interconnected through a cable harness assembly to permit rapid connection for standard test procedures as selected by means of an integral switching system. The switching system includes two four-position function switches located on the front panels of Oscilloscope OS-54/URN-3 and Power Meter-Pulse Counter TS-891/URN-3 and a two-position coaxial r-f switch on Switch-Test Adapter SA-420/URN-3. It is also necessary to interconnect front panel jacks of the units by means of coaxial patch cords. The cable harness and front panel connections are shown in figure 2-33.

The tests provided for the four positions of the two function switches are as listed below. Note that both function switches should be in the same position for any one of the tests.

Switch Position	PANEL NAME	Test
1	OPERATING TEST	R-f peak power Visual pulse shape Output pulse count AN/URN-3 transmitter spectrum
2	RECEIVER SENSITIVITY	Reference burst pulse count Squitter count
3	DELAY SYSTEM	Overall zero-distance time delay Video zero distance time delay
4	GENERAL TEST	Maintenance testing

b. FUNCTIONAL DESCRIPTION. - The theoretical principles upon which the tests listed above are based, a functional description of each of the units involved in these, and a brief circuit description of each of the equipments are given in the following paragraphs. These discussions are based on the block diagrams, figures 2-34 through 2-38. For more detailed information, reference should be made to the technical manuals for these equipments. Overall schematic diagrams of the test equipments are given in the last section of this handbook.

c. PULSE-SWEEP GENERATOR SG-121A/URN-3 - PRINCIPLES OF OPERATION AND FUNCTIONS. - Refer to the block diagram, figure 2-34. Pulse-Sweep Generator SG-121A/URN-3 provides pulsed pairs at a controlled variable rate to simulate the r-f output of one or more airborne Radio Sets AN/ARN-21. The pulse-sweep generator output is a signal which is applied as modulation to Pulse Analyzer-Signal Generator TS-890/URN-3 to provide the required pulsed r-f signal, which simulates the normal input to the radio beacon receiver.

The paired pulse output of the pulse-sweep generator is carefully timed to facilitate measurement of the characteristics of the radio beacon. The spacing between pulses in the pair may be varied from 11 to 13 microseconds in 0.5-microsecond steps, to permit checking that the radio beacon output pulse-pair spacing is within the specified limit of 11.5 to 12.5 ± 0.2 microseconds, and that the beacon will decode for retransmission only those pulse-pairs which are within the same limits. The pulse repetition rate is variable. Continuous variation over the range of 40 to 4,000 pulse-pairs per second permits interrogating the radio beacon at rates which simulate different numbers of Radio Sets AN/ARN-21 within the operating range. Fixed, crystal-controlled rates are also provided. Four separate crystal timing frequencies produce sweep rates for checking the upper and lower tolerance limits of the video unit zero distance delay, 44 and 42 microseconds, respectively, and of the overall zero distance delay, 50.2 and 49.8 microseconds, respectively.

Sweep voltage, in the form of a sawtooth, is provided at exactly one-half of specified rates. A modulation trigger is also provided which is an exact multiple, at an interval of approximately 1,000 microseconds, of the sweep rate, i.e., the modulation trigger times the output pulse-pair. The reason for this arrangement is given in the discussion of test principles, below. A sync trigger is also provided. This trigger is developed from the modulation trigger, which times the pulse-pair at the continuously variable or crystal controlled rates.

d. PULSE ANALYZER-SIGNAL GENERATOR TS-890/URN-3. - Pulse Analyzer-Signal Generator TS-890/URN-3 (figure 2-35) provides an r-f carrier for testing the beacon. It also provides a calibrated receiver for spectrum analysis of the beacon output signal. The pulse analyzer-signal generator is capable of supplying an r-f signal over the complete range of the beacon receiver and of analyzing radio beacon output signals over the complete range of output frequencies.

The r-f signal provided by the signal generator portion of this unit is continuously variable over the range of 1,023 to 1,152 megacycles. Means are also provided for plugging in crystals corresponding to the frequency of any channel within this range, as a fixed frequency source. The amplitude of this signal may be varied over an accurately calibrated range of 0.1 microvolt to 0.5 volt. The specified voltages are for a 50-ohm output. This r-f signal may be either cw or pulsed.

The receiver (analyzer) portion of this unit may be tuned to any frequency in the two bands of 962 to 1,024 and 1,151 to 1,213 mc. Once tuned to a channel, the receiver may be detuned to a narrow band of frequencies 0.8 mc above or below the channel or 1 mc above or below the channel. An attenuator associated with this feature provides 0-db loss when tuned 1 mc off channel, 5-db loss when tuned 0.8 mc off channel, and 40-db loss when tuned "on channel". This arrangement varies receiver sensitivity in such a way that, if the radio beacon output signal has the correct spectral distribution, a meter in the receiver output circuit will read midscale for all five on-channel and off-channel conditions. A separate attenuator, having a range of 30 db, permits varying receiver output so that the meter may be set to midscale for the on-channel condition. Thus, any deviations from the specified spectral characteristics of the radio beacon output will be indicated by corresponding deviations of the meter reading.

e. POWER METER-PULSE COUNTER TS-891/URN-3. - Power Meter-Pulse Counter TS-891/URN-3 (figure 2-37) includes two functionally separate circuits in the one unit.

(1) POWER METER CIRCUIT. - The power meter circuit is a metered variable d-c source, used to bias the diode in Switch-Test Adapter SA-420/URN-3 for power measurement. Varying the bias changes the diode clipping level and causes less of the detected positive pulse to be passed on for display on the oscilloscope. By adjusting the bias to the point where the detected pulse is just eliminated from the scope presentation, the d-c voltage is made equal to

the peak amplitude of the pulse. Since the d-c voltage is a measured quantity, a direct indication of peak pulse amplitude, and hence peak power, is obtained. The meter that indicates the magnitude of the d-c voltage is calibrated in kilowatts.

(2) PULSE COUNTER CIRCUIT. - The pulse counter circuit is arranged to perform several functions.

When counting the beacon "squitter" output pulses, the pulse counter accepts these pulses, shapes them for uniformity, and applies them to a vacuum tube measuring circuit which varies the meter current in direct proportion to pulse rate. The associated meter is calibrated directly in pulses per second, and has two ranges of 80 to 800 to 8, 000 pulses per second. Thus, the circuit measures the squitter output directly. Squitter count is defined as the random output of the beacon NOT due to interrogation.

When counting the reply rate (that is, those pulses that pass through the beacon receiver as a direct result of interrogations), the pulses are applied to the pulse counter exactly as for squitter count. In addition, however, interrogation pulses from Pulse-Sweep Generator SG-121A/URN-3 are applied to the counter circuit and a gate circuit. The gate circuit prevents the passage of pulses through the counter, except for a 14-microsecond period following delivery of an interrogation signal. The start of the 14-microsecond gate is delayed 12 microseconds to compensate for a corresponding delay through the receiver. Thus the counter is gated off for all pulses except direct replies.

In addition to squitter count and reply count, a four-position FUNCTION switch also permits the counter to accept either negative or positive pulses from any external source.

f. OSCILLOSCOPE OS-54/URN-3. - Oscilloscope OS-54/URN-3 (figure 2-36) is a versatile, wide-band oscilloscope with a triggered sweep. Sweep trigger may be from a recurrent source within the oscilloscope or from an external source. Sweep speed may be varied over the range of 0.4 to 40,000 microseconds. Sweep blanking is provided. The sweep is inactive and blanked out in the absence of a trigger. The vertical amplifier bandwidth, between those frequencies which are 3 db down, is 5 cycles to 3 megacycles.

The oscilloscope provides timing markers and calibrating voltage to permit accurate measurement of signal waveform amplitude and pulse width. Markers are at intervals of 1 microsecond and 10 microseconds, and may be superposed on the signal at will. The calibrating voltage permits peak-to-peak amplitude

measurement over a range of 0.1 to 100 volts. An additional feature, which permits observation of the leading edge of sharply rising wavefronts, is an optional signal delay of 0.3 microsecond.

g. SWITCH-TEST ADAPTER SA-420/URN-3. - Switch-Test Adapter SA-420/URN-3 (figure 2-38) consists of a heavy duty coaxial switch and a pick-off diode. The switch is used to transfer the radio beacon transmitter output power from the antenna to a dummy load and the pick-off diode is used to supply detected signal to the test equipment. A biasing voltage, developed in Power Meter-Pulse Counter TS-891/URN-3, is applied to the diode to permit power measurement by the slide-back method.

h. TEST PRINCIPLES. - This paragraph shows how the test units described above are connected together for the various positions of the test function switches, and explains the theory behind each test thus made possible.

(1) POSITION 1. - The connections shown in figure 2-33, as applicable of the test function switches in position 1, permit the operating tests to be made by the simple adjustment of just a few of the unit controls.

The oscilloscope is reset for the correct sensitivity and the required 25-microsecond sweep. The signal at the video input of the beacon is fed through switch contacts of Power Meter-Pulse Counter TS-891/URN-3 to the trigger input of the oscilloscope. This synchronizes the oscilloscope so that the video pulse-pair triggers a sweep trace.

The r-f output of the radio beacon is fed to the antenna through Switch-Test Adapter SA-420/URN-3. This r-f signal is detected by the diode in the switch-test adapter, fed through switch contacts of the power meter-pulse counter, and applied to the oscilloscope signal input terminals. Thus the detected r-f signal will be displayed on the oscilloscope for all position 1 tests.

The paried pulses generated by Pulse-Sweep Generator SG-121A/URN-3 are fed directly to the modulator input of Pulse Analyzer-Signal Generator TS-890/URN-3. The resulting pulsed r-f signal is used to interrogate the radio beacon. The radio beacon r-f output signal is fed back to the pulse analyzer section from the ANT RF connector to the ANALYZER INPUT connector.

How these signals are used for the various operating tests is described in the following subparagraphs:

(a) R-F PEAK POWER TEST. - R-f peak power is tested by observation of the video waveform on the oscilloscope. By means of the variable d-c voltage in the power meter-pulse counter, the bias on the cathode of the detector

diode is varied to cut off the diode. When the diode is cut off to just the point where the video signal is no longer presented on the oscilloscope, the d-c voltage is equal to the peak value of the r-f signal. Because the deflection of the PEAK POWER METER corresponds to the d-c voltage, the peak power may be read directly from the meter in kilowatts.

(b) VISUAL PULSE SHAPE. - The relative amplitude of any point on the video pulse may be readily determined by means of the illuminated graph screen on the oscilloscope. Pulse time relationships may be accurately measured by means of 1- and 10-microsecond markers provided by the oscilloscope.

(c) OUTPUT PULSE COUNT. - The detected output of the radio beacon is fed directly to the counter circuit for the operating test. By proper setting of the power meter-pulse counter controls, the PULSES PER SECOND meter will provide a continuous indication of the number of radio beacon output pulses per second.

(d) BEACON SPECTRUM TEST. - The radio beacon spectrum test is made by applying beacon output r-f pulses to the pulse analyzer. The analyzer is a sharply tuned r-f voltmeter which provides a meter indication of relative output power.

A reference indication is first made at the center frequency of the channel by adjusting a variable attenuator for a midscale POWER COMPARISON INDICATOR meter reading. When the analyzer is set to this frequency, an integral fixed attenuator reduces the metering sensitivity by 40 db. The analyzer is next tuned to a frequency 0. 8 mc away from the channel center frequency. Simultaneously, the attenuation is reduced 35 db. Because the spectrum characteristic requires that carrier energy by 35 db down at this frequency, the POWER COMPARISON INDICATOR meter will remain at the reference point if the beacon pulse characteristic is correct. If the characteristic deviates from specification, the meter indication will deviate correspondingly. A similar measurement is made on the other side of center frequency.

The same procedure is used to measure carrier energy at ± 1 mc with zero attenuation.

(2) POSITION 2. - The interconnections shown in figure 2-33, as applicable to position 2 of the test function switches, permit the receiver sensitivity tests to be made.

The oscilloscope sensitivity is correctly preset, and a 500-microsecond sweep is provided. North and auxiliary bursts, from the SYNC OUT jack of the

beacon, are fed to the TRIGGER IN jack of the oscilloscope through switch contacts in the power meter-pulse counter. This synchronizes the sweep trace from the reference bursts so that the number of pulses in the bursts may be visually counted.

The signal at the video input of the beacon is fed through switch contacts of the power meter-pulse counter to the SIGNAL IN jack of the oscilloscope. Thus, the video signal at the receiver output is displayed on the oscilloscope screen and the reference bursts may be observed for counting.

The TEST OUTPUT signal, at the radio beacon receiver output, is applied directly to the counter input. This permits checking that the squitter count is correct and that reply pulses are going through the receiver.

Paired-pulse output from the pulse-sweep generator is applied to the pulse analyzer-signal generator and used to interrogate the beacon at any desired rate.

The details of the test are described in the following subparagraphs:

(a) REFERENCE BURST PULSE COUNT. - The number of pulses in the reference pulses, as well as the spacing between pulses, may be readily checked by observation on the oscilloscope. By manipulation of the oscilloscope synchronization control, it is possible to lock the trace on any of the auxiliary bursts or on the north burst. The 1-microsecond and 10-microsecond markers in the oscilloscope permit accurate measurement of pulse spacing.

(b) SQUITTER COUNT. - The squitter is the output of the receiver not attributable to an actual interrogation. This signal is readily counted by stopping the interrogation signal from being generated in the pulse-sweep generator and by adjusting the power meter-pulse counter controls for squitter count. In addition to supplying squitter pulses when the interrogation rate is below 2,700 pulse-pairs per second, the squitter control circuits in the receiver are required to limit the number of output pulses when the radio set is being interrogated by more than 2,700 pulse-pairs per second. Both of these squitter control circuit functions may be checked by varying the interrogation rate of the test signal from the pulse sweep generator.

(c) REPLY COUNT. - The reply count provides an indication of the number of interrogation pulses which pass through the receiver. The pulse counter circuit is made responsive only to reply signals by a gate circuit. The gate is activated by the interrogation signals and permits the counter to indicate only those receiver output signals that are the result of an interrogation signal.

(d) RECEIVER SENSITIVITY. - By noting the output amplitude of the pulse analyzer-signal generator required to obtain a reply count equal to 60 percent of the interrogation rate, an accurate indication of receiver sensitivity may be obtained.

(3) POSITION 3, OVERALL ZERO DISTANCE DELAY. - The interconnections shown in figure 2-33 as applicable to position 3 of the TEST FUNCTION SWITCHES permit the overall zero distance delay and video zero distance delay through the radio beacon to be checked. A change in connection for the two delay checks is made through a switch in the pulse-sweep generator.

The sawtooth sweep output of the pulse-sweep generator is fed to the oscilloscope as the sweep deflection voltage. Paired-pulse output of the pulse-sweep generator is fed through the pulse analyzer-signal generator to interrogate the beacon. For the overall zero distance delay measurement, detected r-f output of the pulse analyzer-signal generator is fed to one input of a two-channel mixer in the pulse sweep generator. The r-f output of the radio beacon is detected by the diode in the switch-test adapter and fed to the remaining input of the two-channel mixer. The input signals to the mixer are selected by switch contacts ganged to a crystal selector switch described below.

The mixer presents the interrogation signal, at the input and output of the overall radio beacon, to the oscilloscope for display. Assuming proper timing, the input and output signals will be superposed. By means of crystal timing circuits in the pulse-sweep generator the interrogation signals are spaced at precise intervals to provide a reference delay used for measurement of the overall delay of the radio beacon. This reference delay will be either 49.8 or 50.2 microseconds, depending on the setting of the crystal selector switch. The sweep period will be exactly half this figure so that two sweeps correspond to one reference delay interval. The output pulse will be displayed approximately 1,000 microseconds after the input pulse at a precise multiple of the reference delay. Because of the sweep multiplication provided by using two sweeps per delay interval, and because any error in beacon delay is allowed to accrue through the many delay intervals in the 1,000-microsecond period, any small error in the timing of the overall zero distance radio beacon delay will cause a noticeable shift in the superposition of the input and output pulse-pairs displayed on the oscilloscope screen. By checking superposition at multiples of the 49.8- and 50.2-microsecond reference delays, it may readily be seen that the beacon delay is between these two figures and is, therefore, within tolerance.

(4) POSITION 4. - When the TEST FUNCTION switches are placed in position 4, the input connections of the oscilloscope are removed. Each one of the test units may then be used as an independent piece of test equipment. The oscilloscope sweep and signal circuits may then be adjusted by means of front panel controls for observation of any desired waveform in the equipment. Signal and sync voltages may be fed to the oscilloscope by means of flexible test leads. With this arrangement, the number of operating tests is extended to include any which may be later conceived and the test equipment may be used as an aid in troubleshooting the radio beacon.

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(4) POSITION 4. - When the TEST FUNCTION switches are placed in position 4, the input connections of the oscilloscope are removed. Each one of the test units may then be used as an independent piece of test equipment. The oscilloscope sweep and signal circuits may then be adjusted by means of front panel controls for observation of any desired waveform in the equipment. Signal and sync voltages may be fed to the oscilloscope by means of flexible test leads. With this arrangement, the number of operating tests is extended to include any which may be later conceived and the test equipment may be used as an aid in troubleshooting the radio beacon.

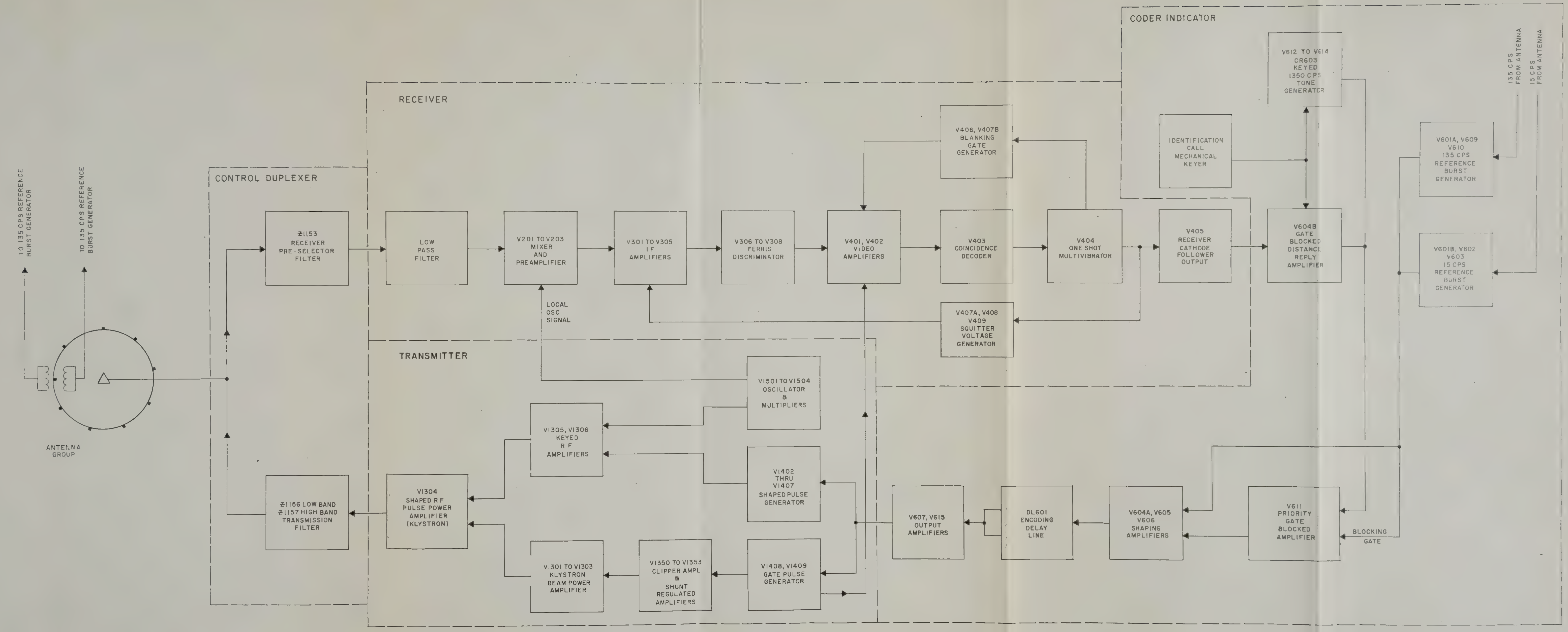


Figure 2-1. Radio Set AN/GRN-9, Simplified Overall Block Diagram

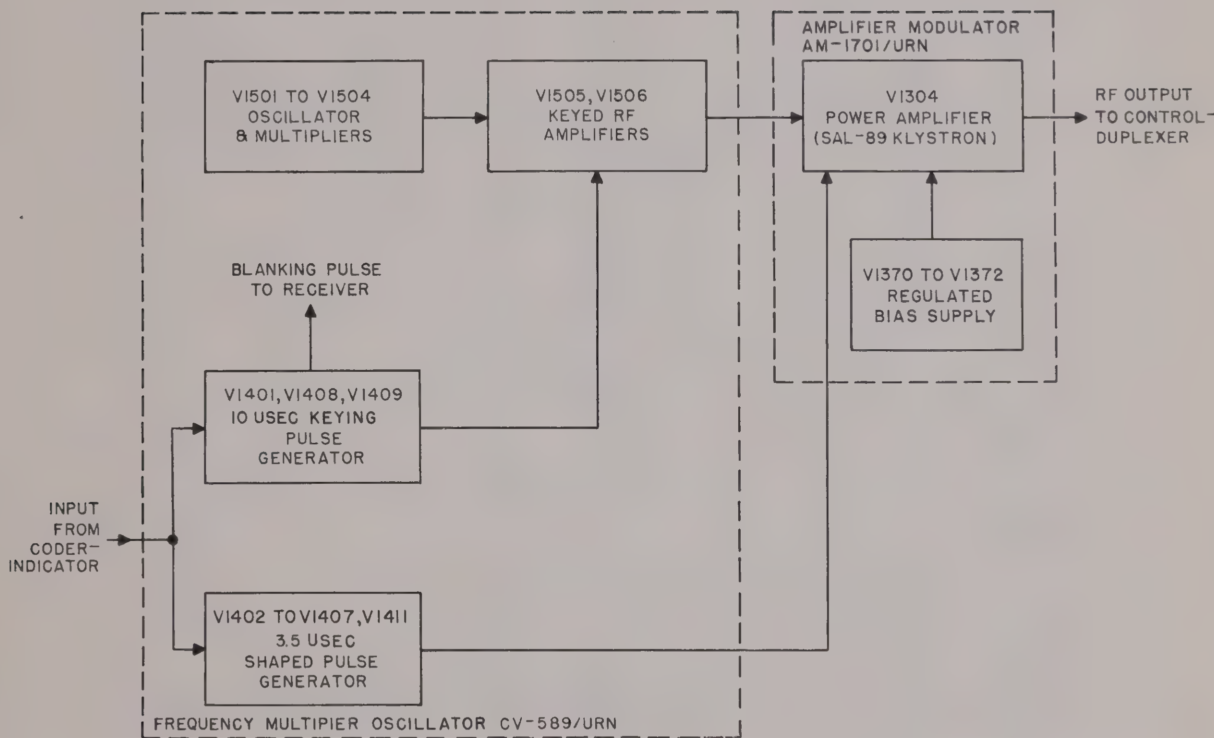


Figure 2-1. 1. Radio Sets AN/GRN-9A and AN/SRN-6, Amplifier-Modulator and FMO, Simplified Block Diagram

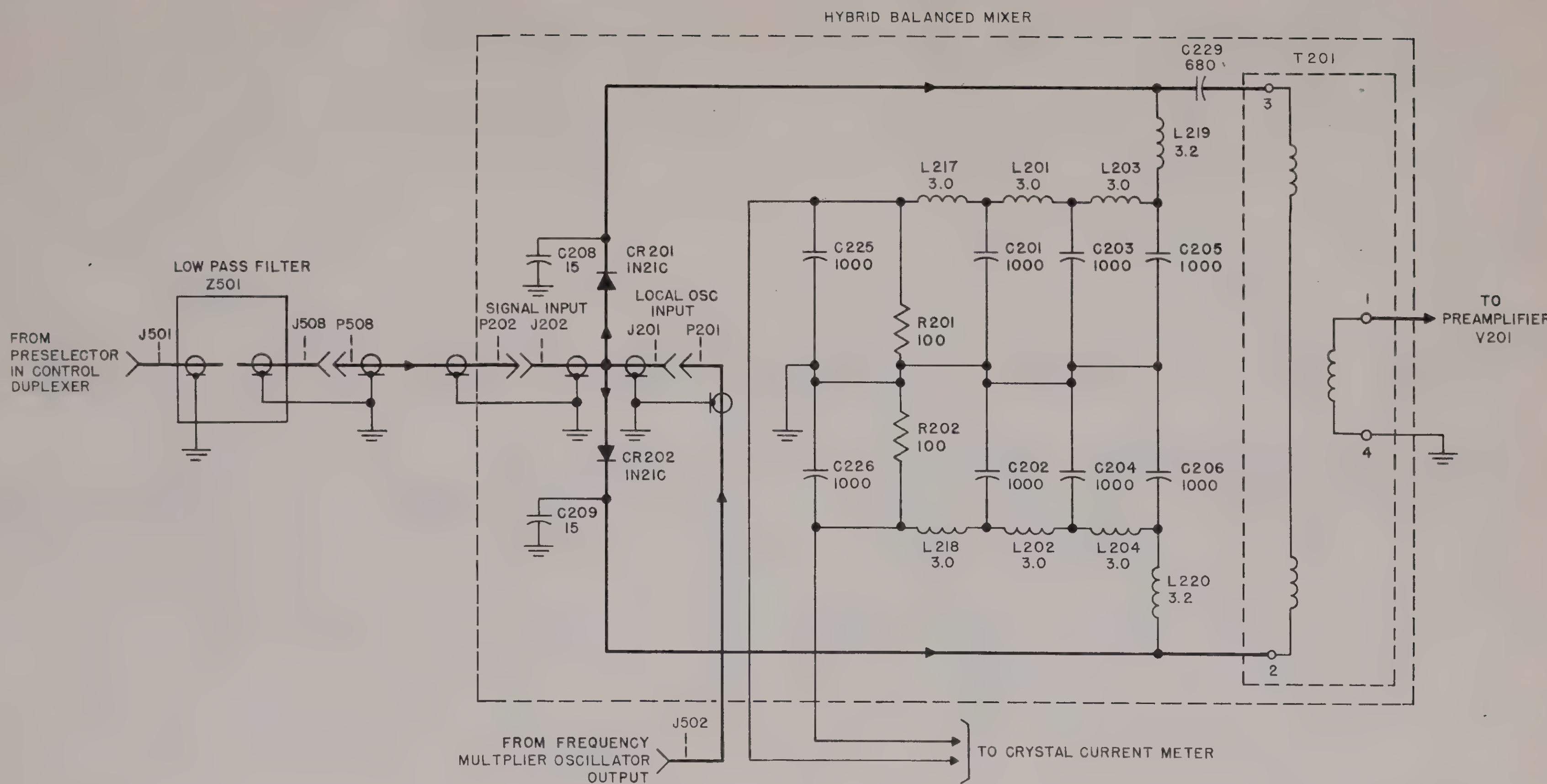


Figure 2-2. Radio Receiver R-824/URN, Hybrid Balanced Mixer, Simplified Block Diagram

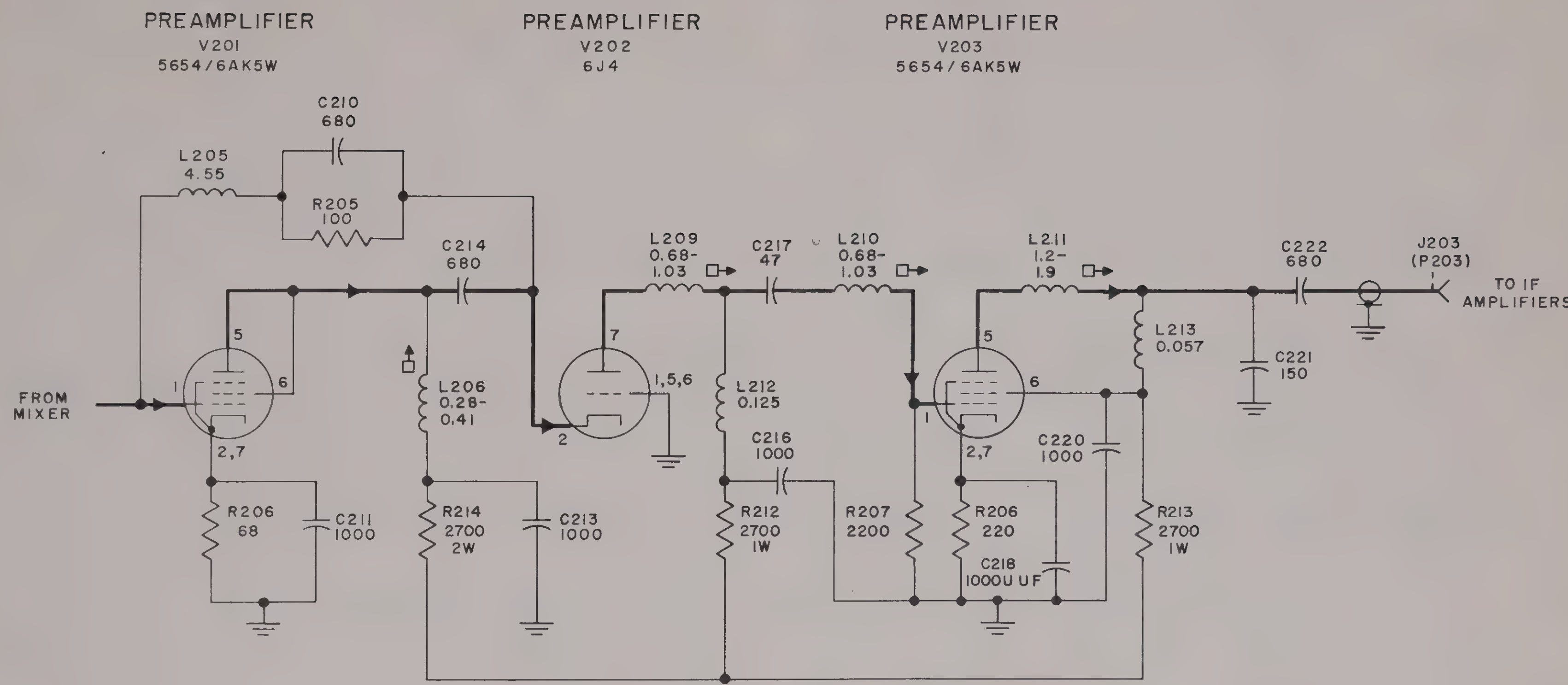


Figure 2-3. Radio Receiver R-824/URN, Preamplifier, Simplified Schematic Diagram

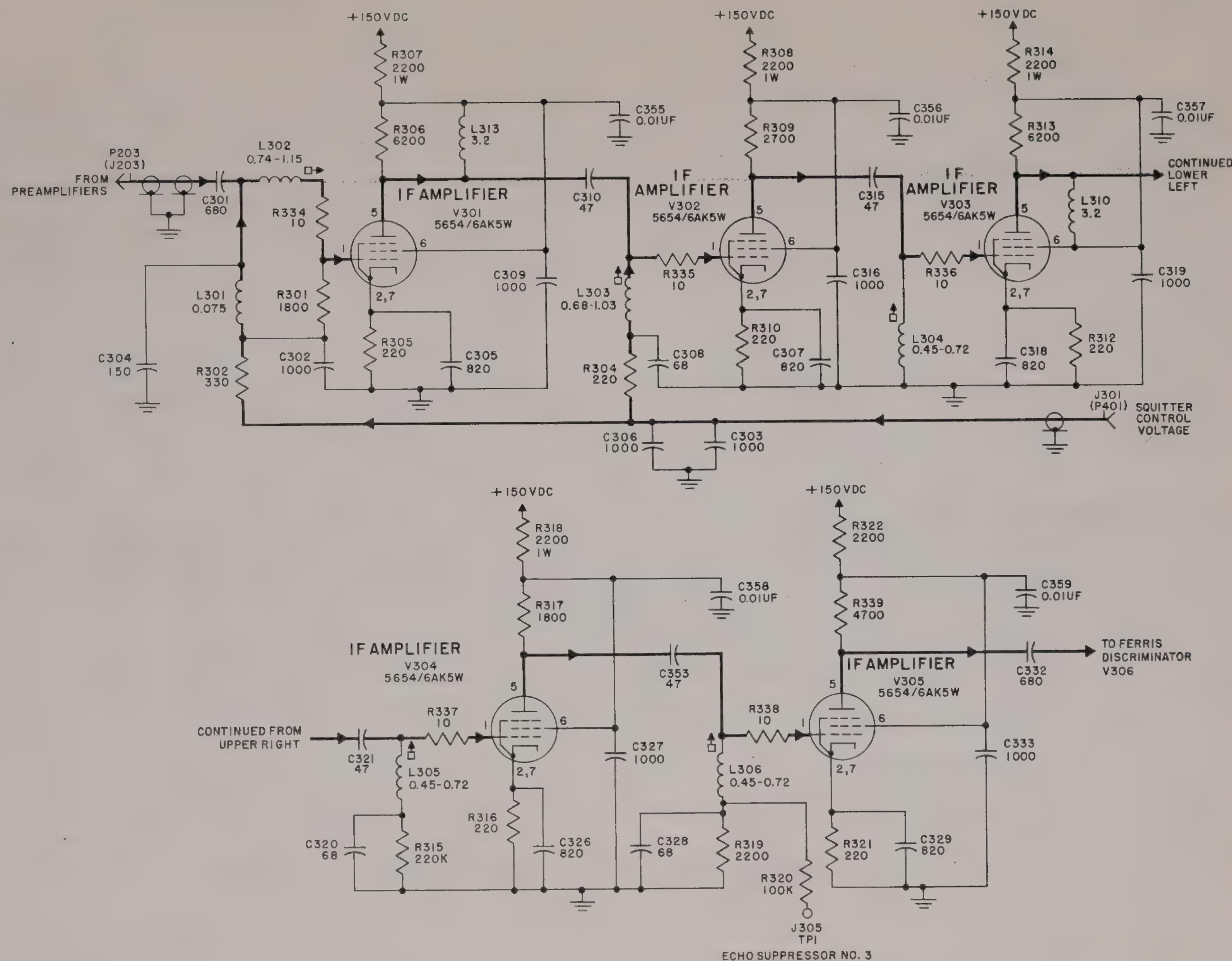


Figure 2-4. Radio Receiver R-824/URN, I-f Amplifier Simplified Schematic Diagram

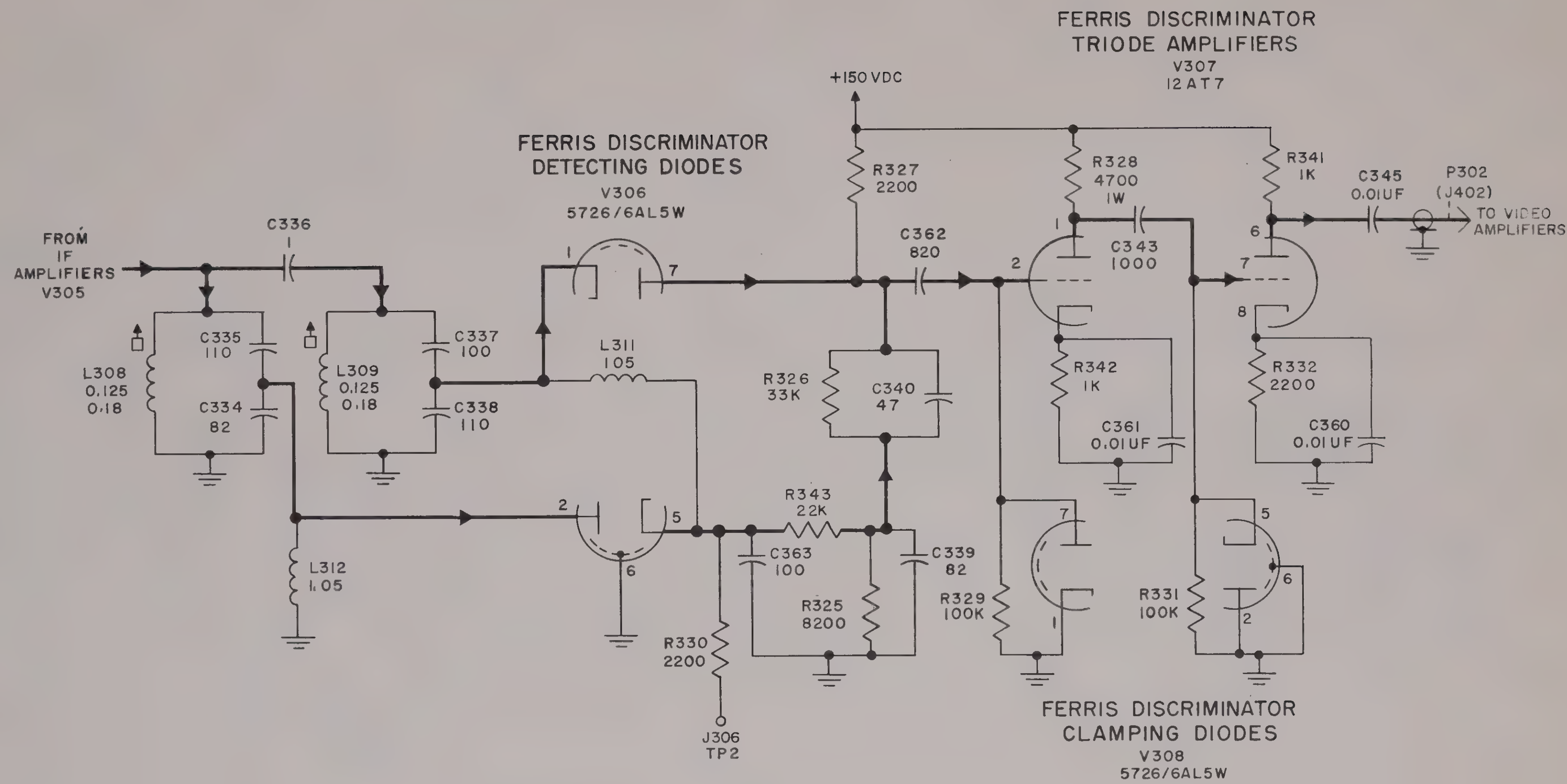


Figure 2-5. Radio Receiver R-824/URN, Ferris Discriminator, Simplified Schematic Diagram

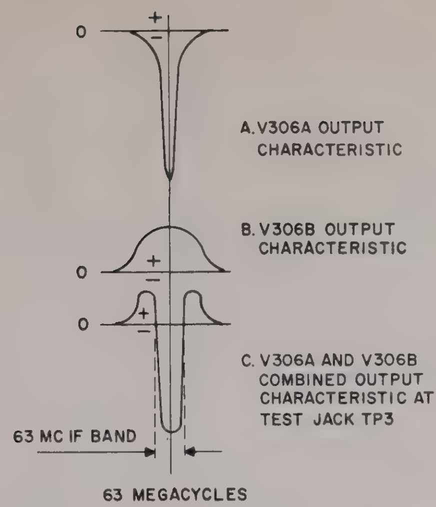


Figure 2-6. Radio Receiver R-824/URN, Ferris Discriminator CW Response Curves

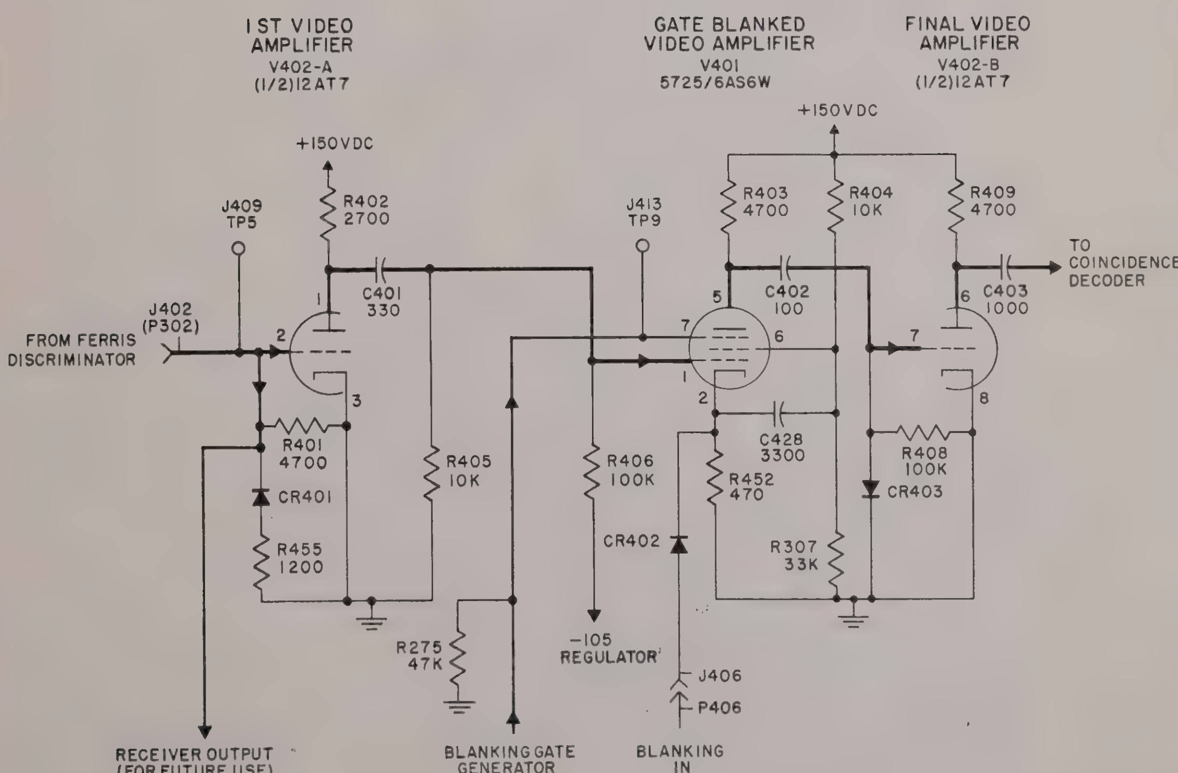


Figure 2-7. Radio Receiver R-824/URN, Video Amplifier, Simplified Schematic Diagram

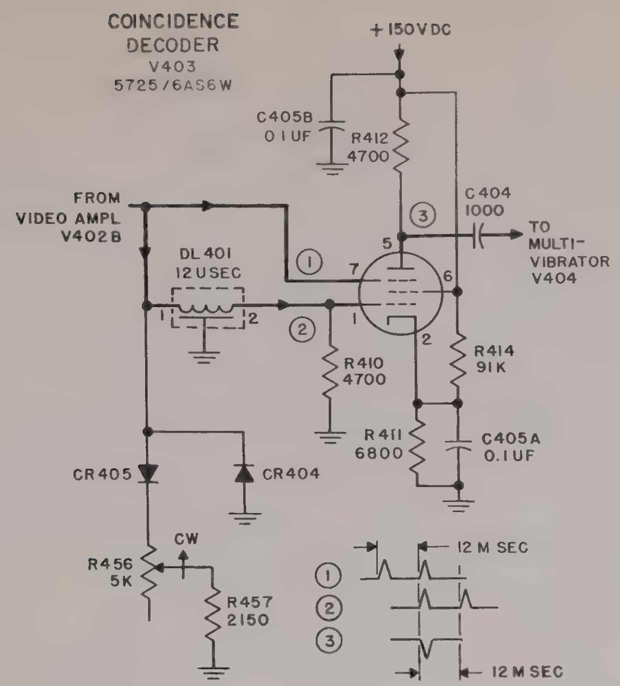


Figure 2-8. Radio Receiver R-824/URN, Coincidence Decoder, Simplified Schematic Diagram

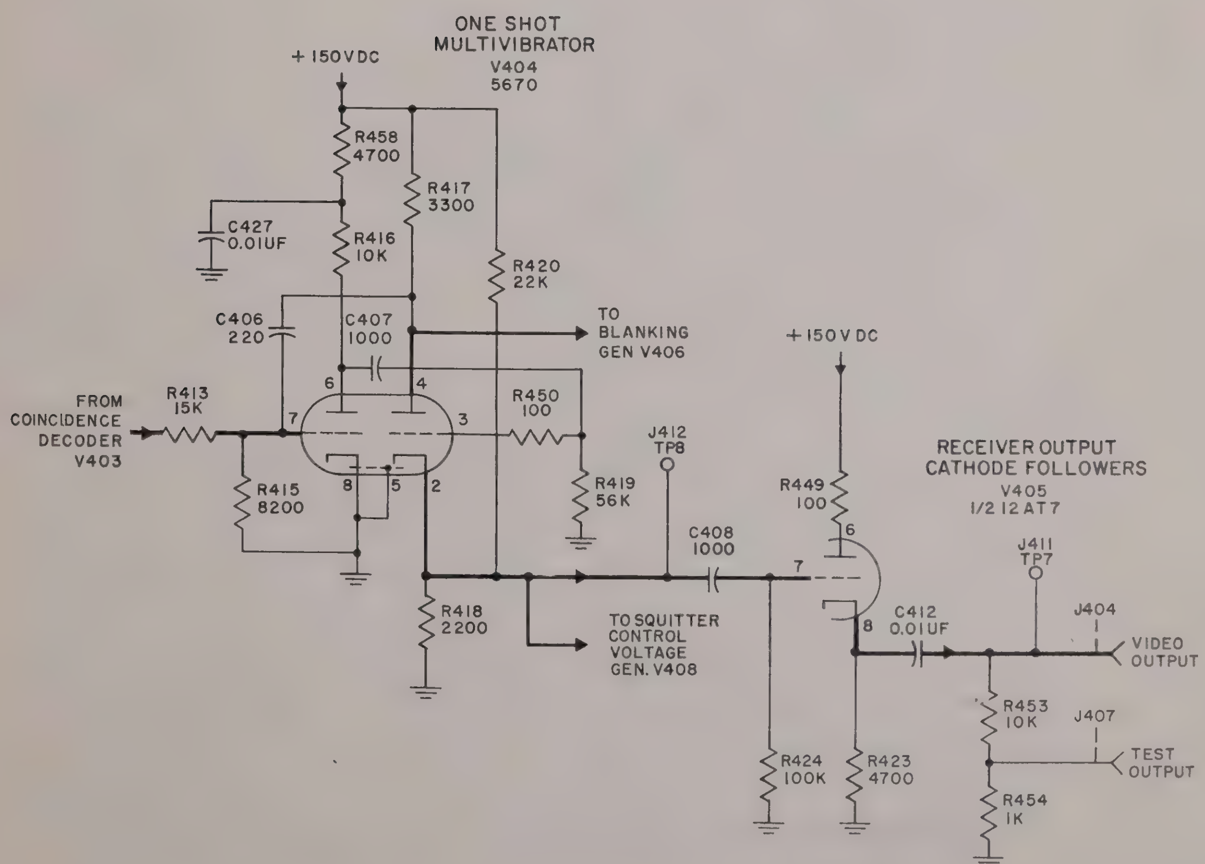


Figure 2-9. Radio Receiver R-824/URN, One-Shot Multivibrator and Receiver Output, Simplified Schematic Diagram

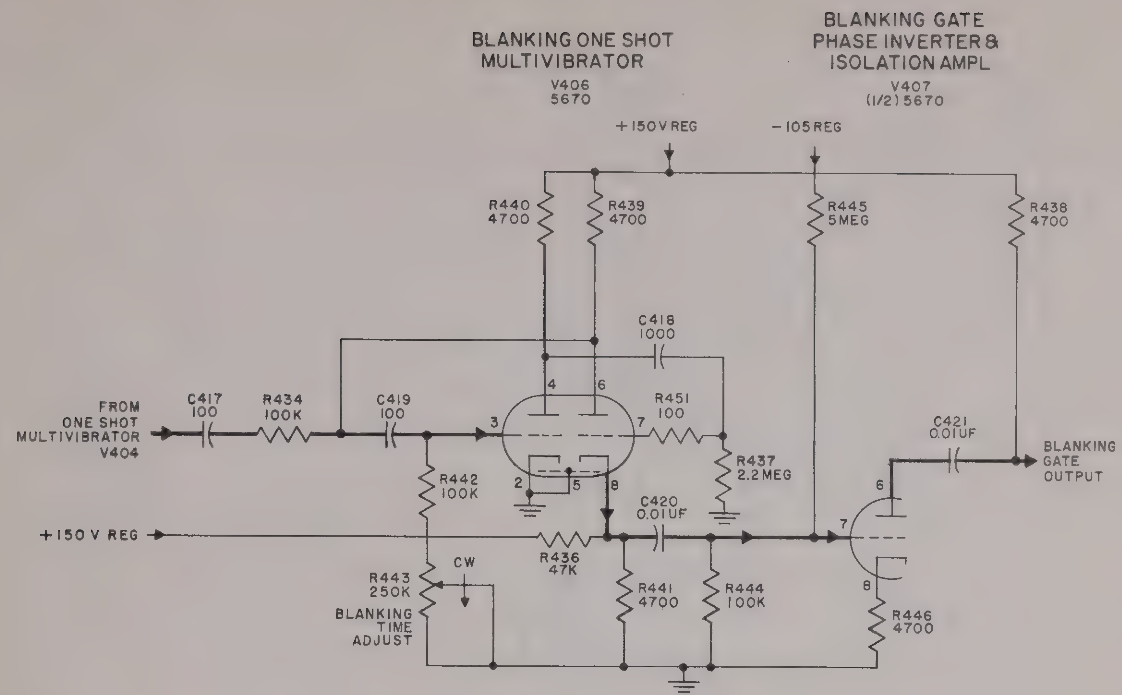


Figure 2-10. Radio Receiver R-824/URN, Blanking Gate Generator, Simplified Schematic Diagram

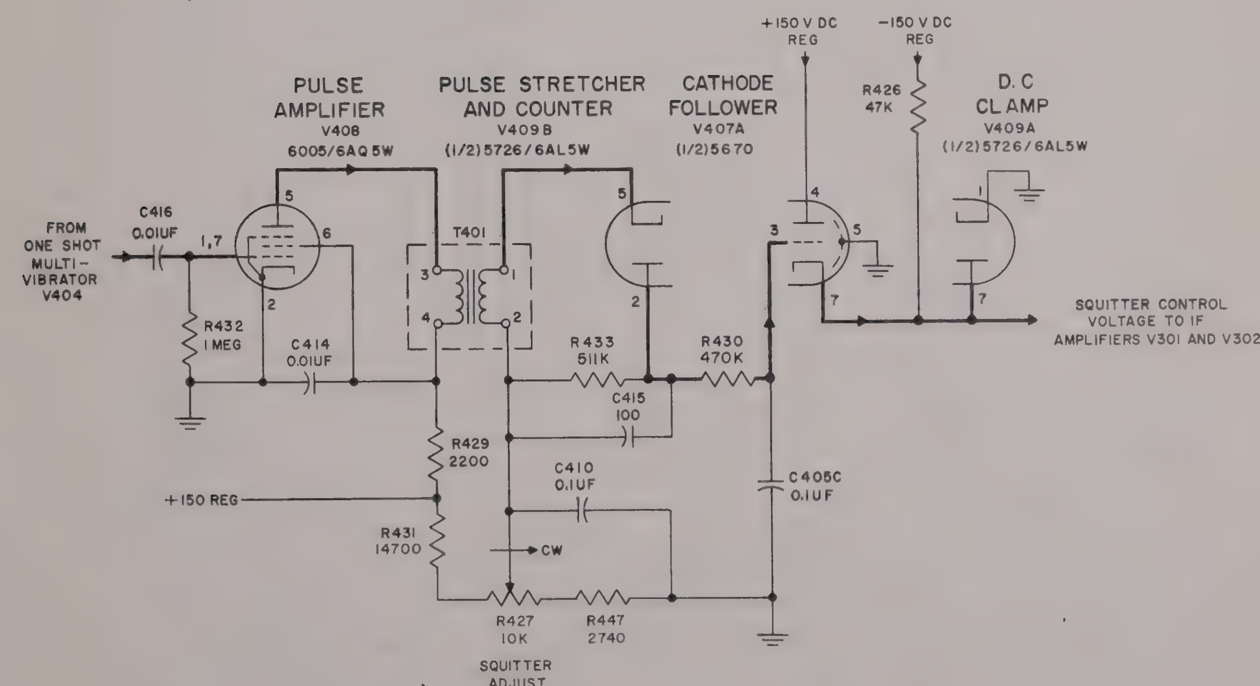


Figure 2-11. Radio Receiver R-824/URN, Squitter Control Voltage Regulator, Simplified Schematic Diagram

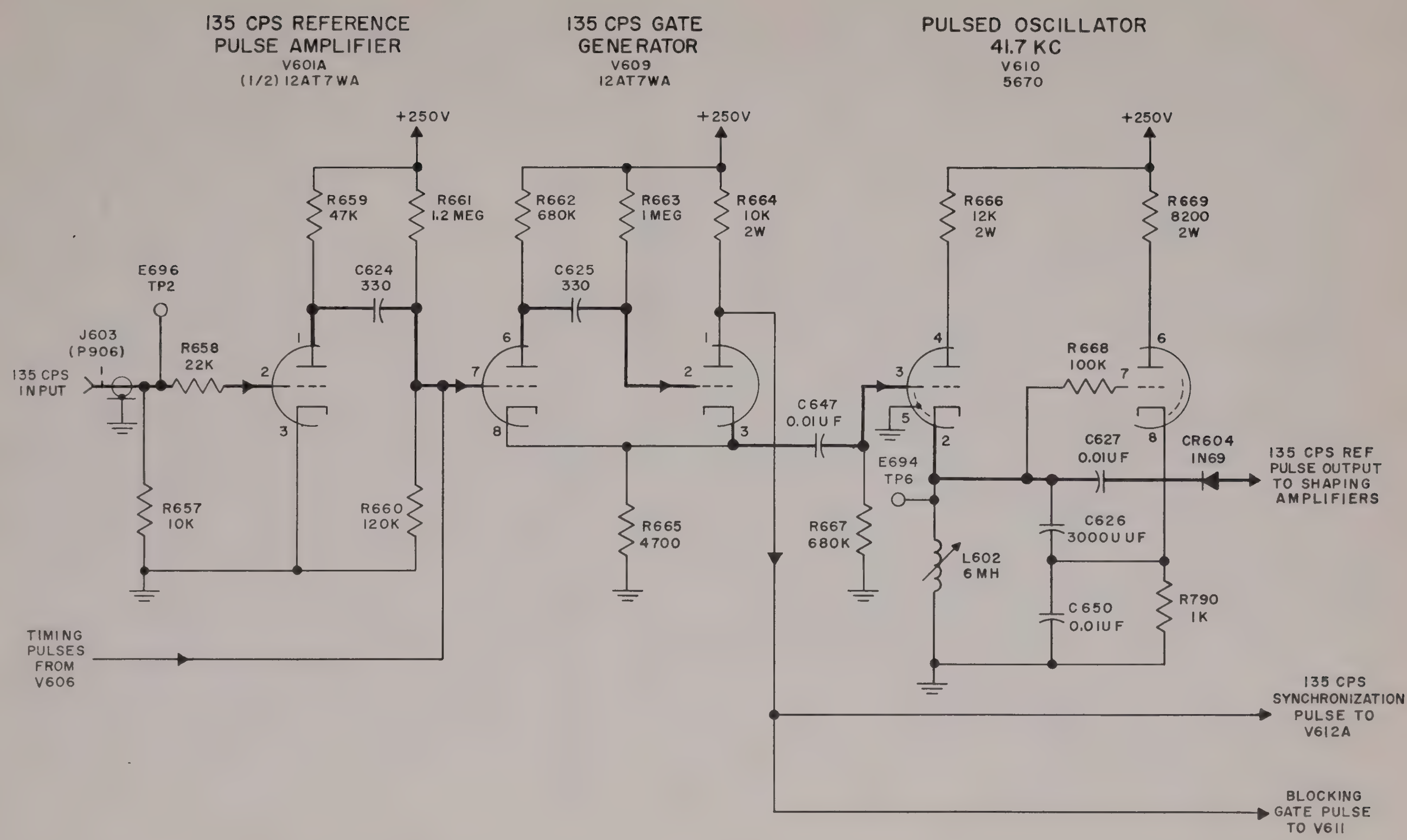


Figure 2-12. Coder-Indicator KY-235/URN, 135-cps Reference Burst Generator, Simplified Schematic Diagram

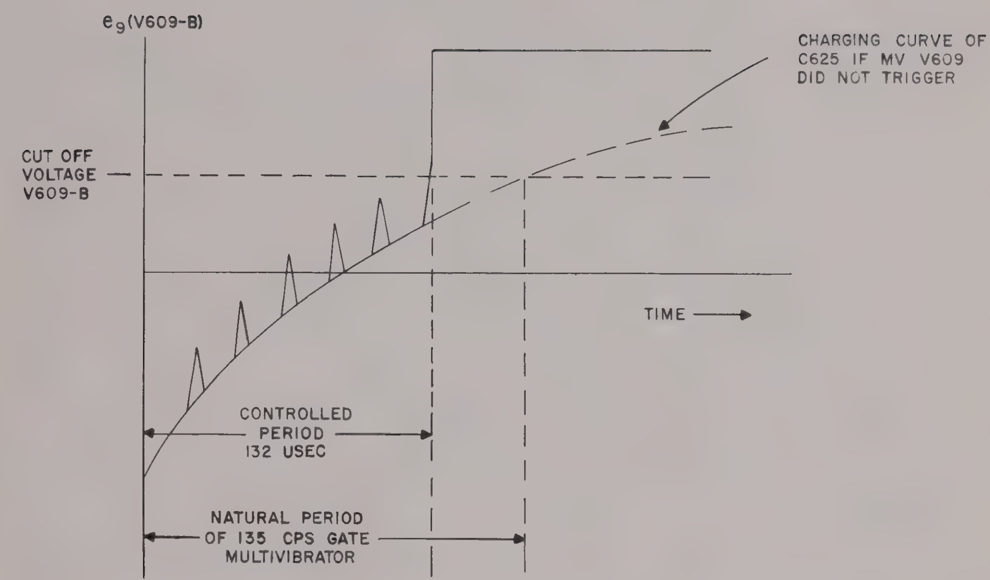


Figure 2-13. Coder-Indicator KY-235/URN, Grid Voltage Curve, V609B During Charge Time of C625

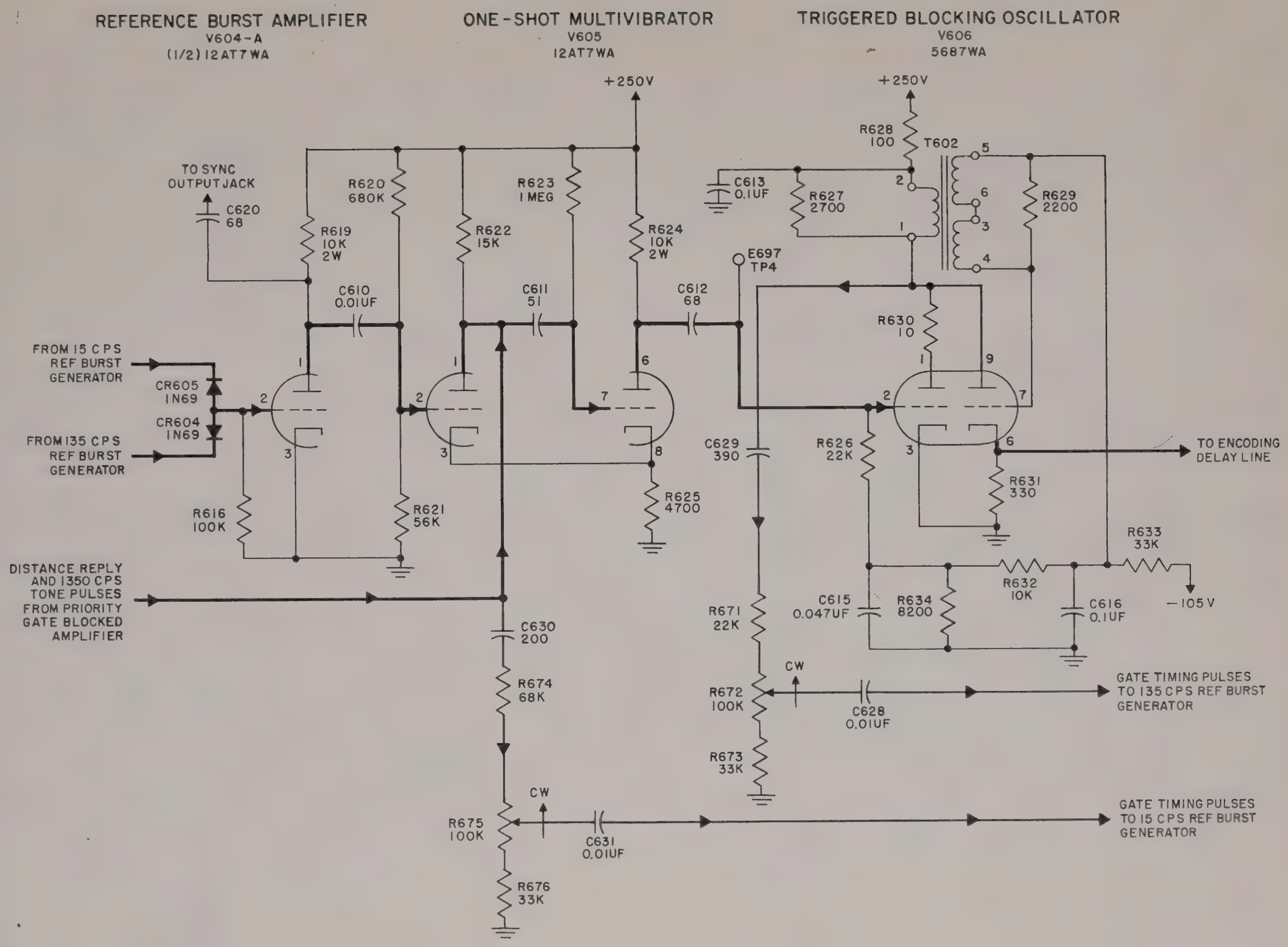


Figure 2-14. Coder-Indicator KY-235/URN, Shaping Amplifier, Simplified Schematic Diagram

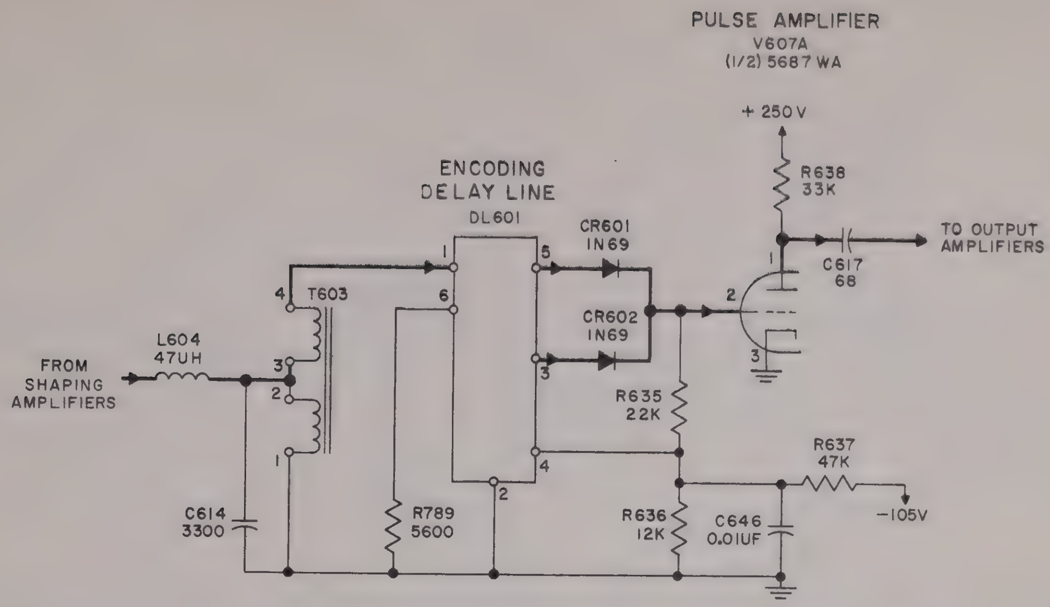


Figure 2-15. Coder-Indicator KY-235/URN, Double Encoding Circuit, Simplified Schematic Diagram

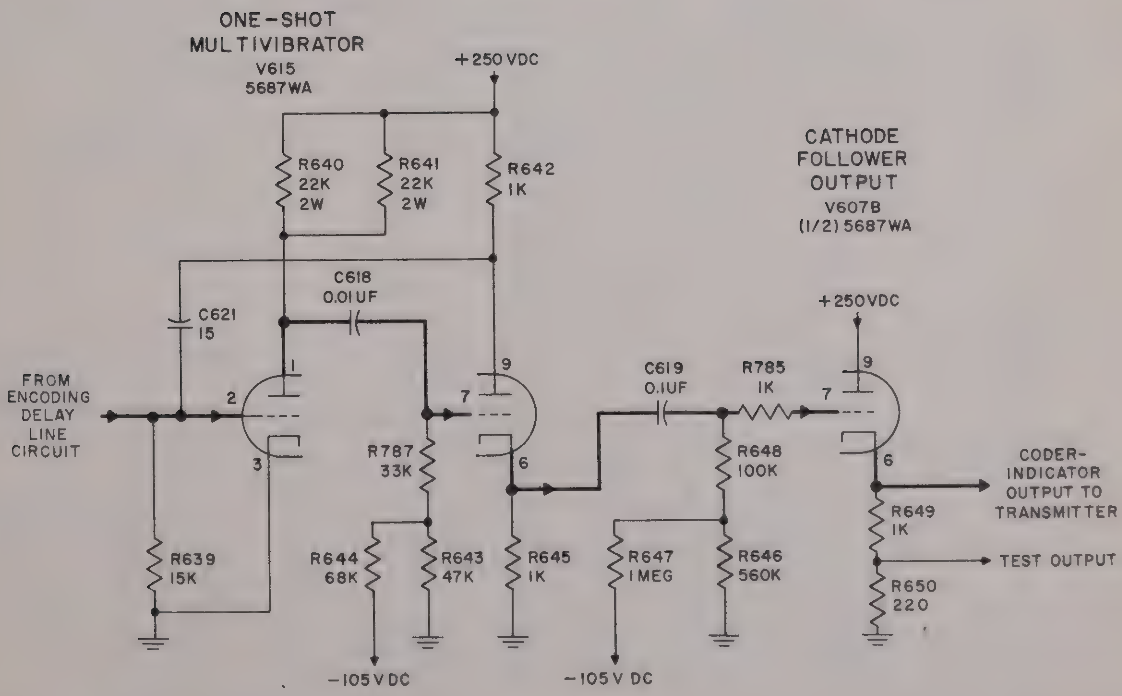


Figure 2-16. Coder-Indicator KY-235/URN, Output Amplifier, Simplified Schematic Diagram

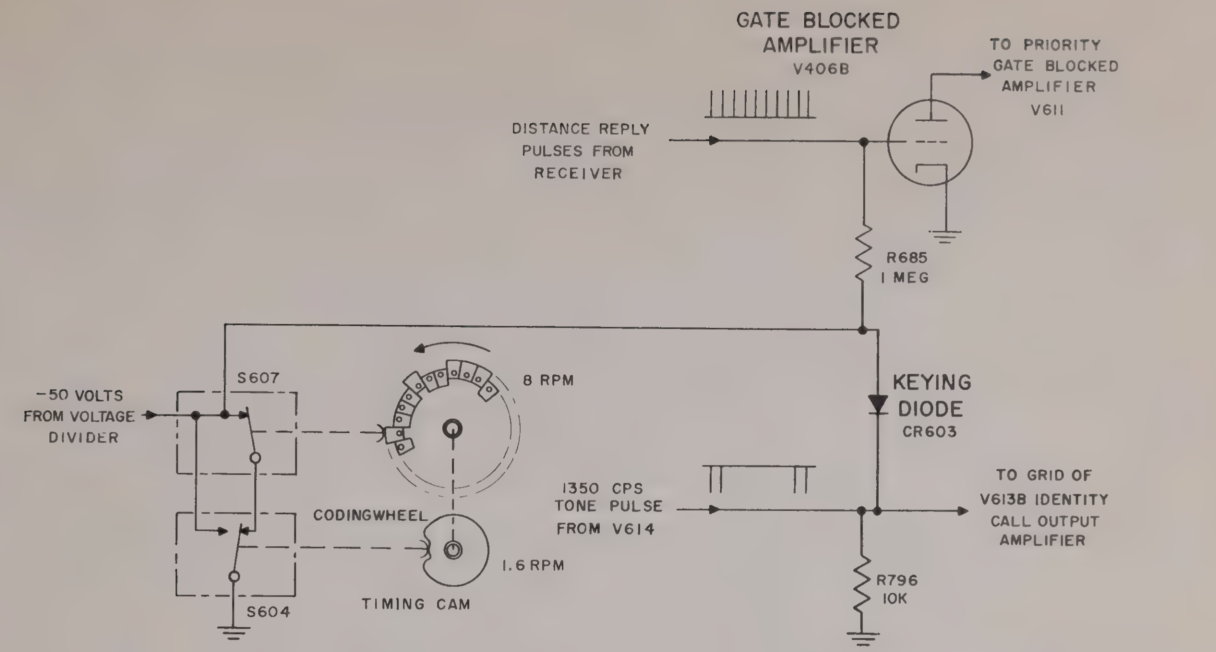


Figure 2-17. Coder-Indicator KY-235/URN, Control Function of Identity Call Mechanical Keyer, Simplified Schematic Diagram

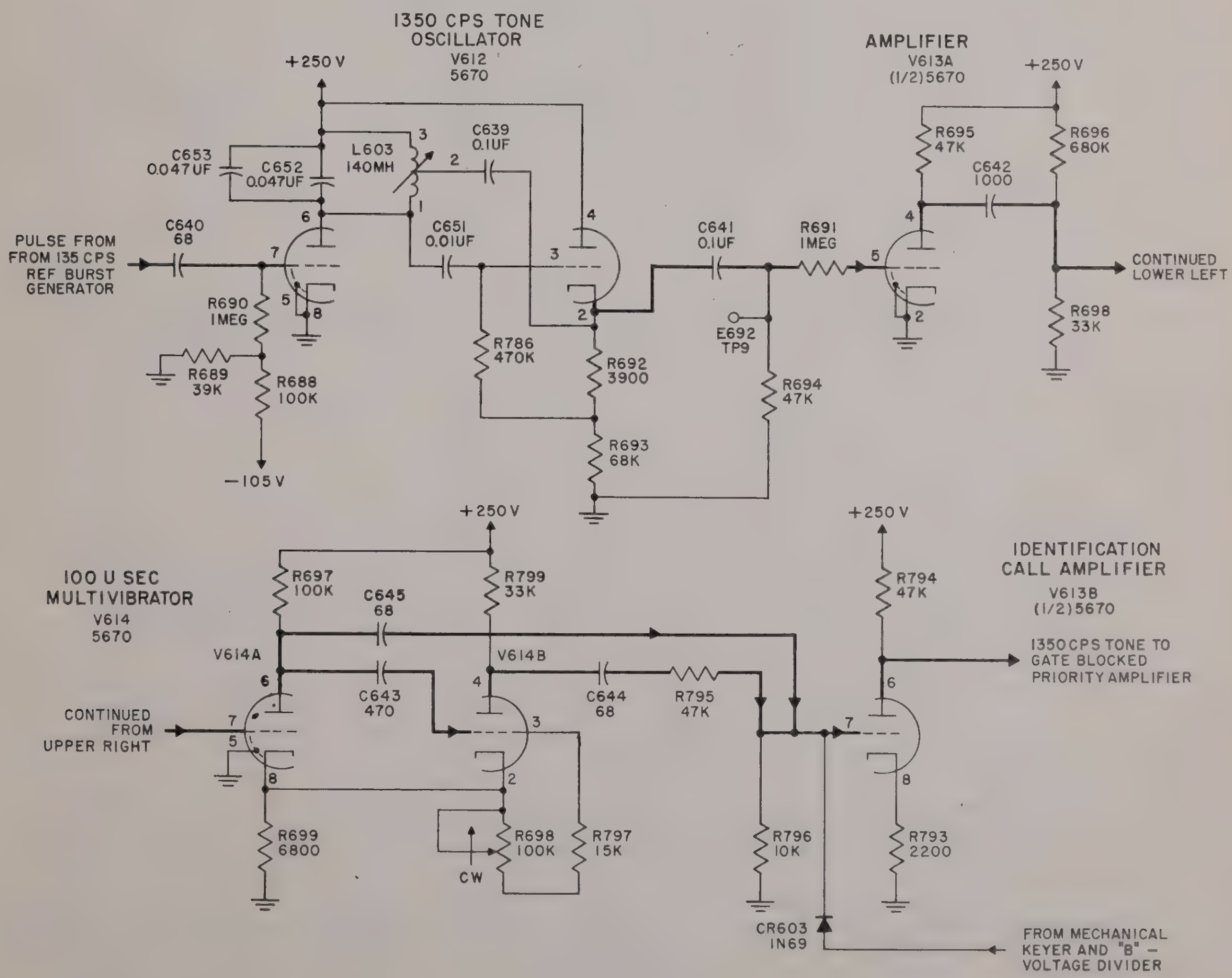


Figure 2-18. Coder-Indicator KY-235/URN, Keyed 1,350-cps Tone Generator, Simplified Schematic Diagram

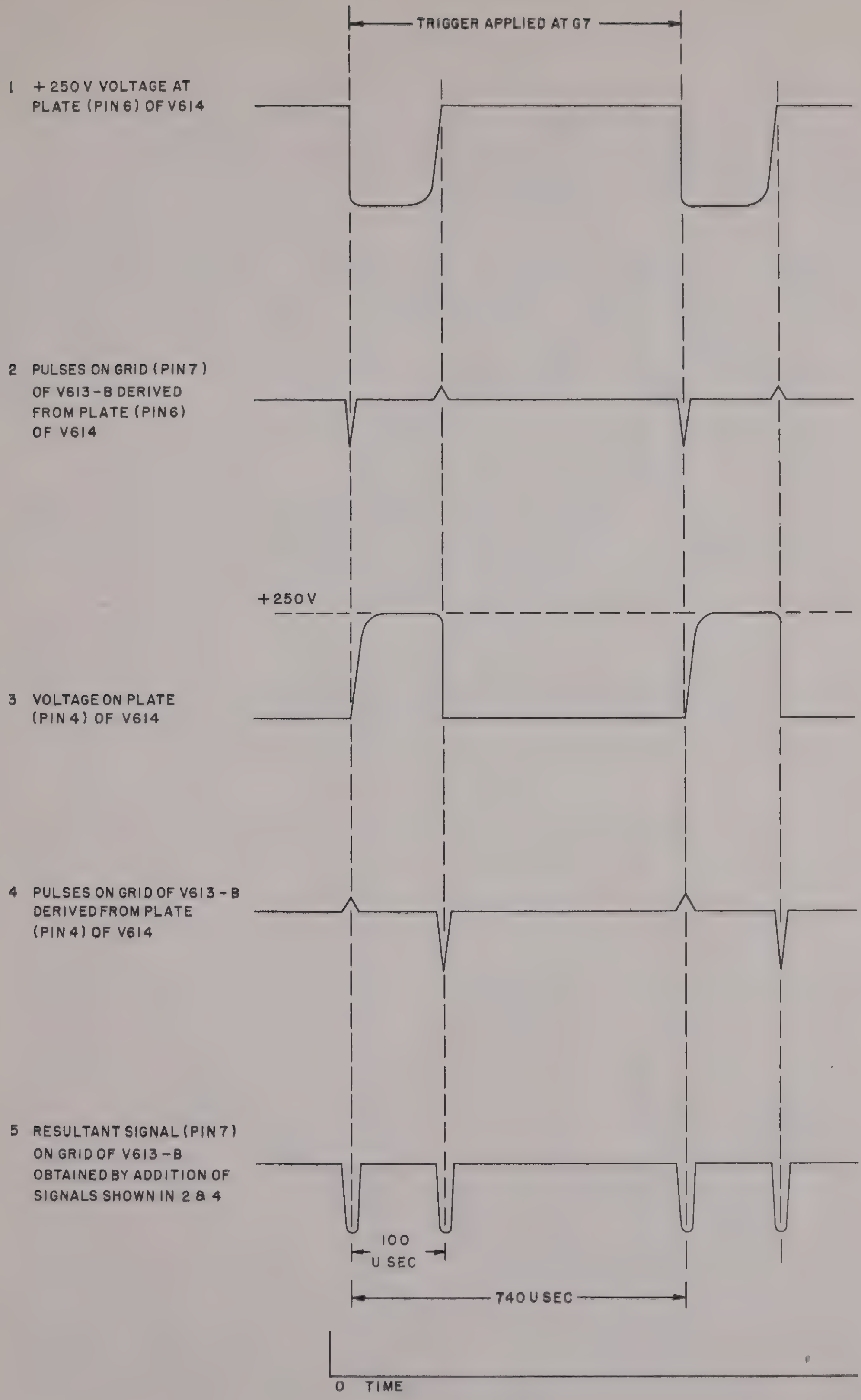


Figure 2-19. Coder-Indicator KY-235/URN, Development of Pulse Pairs of Grid of V613B

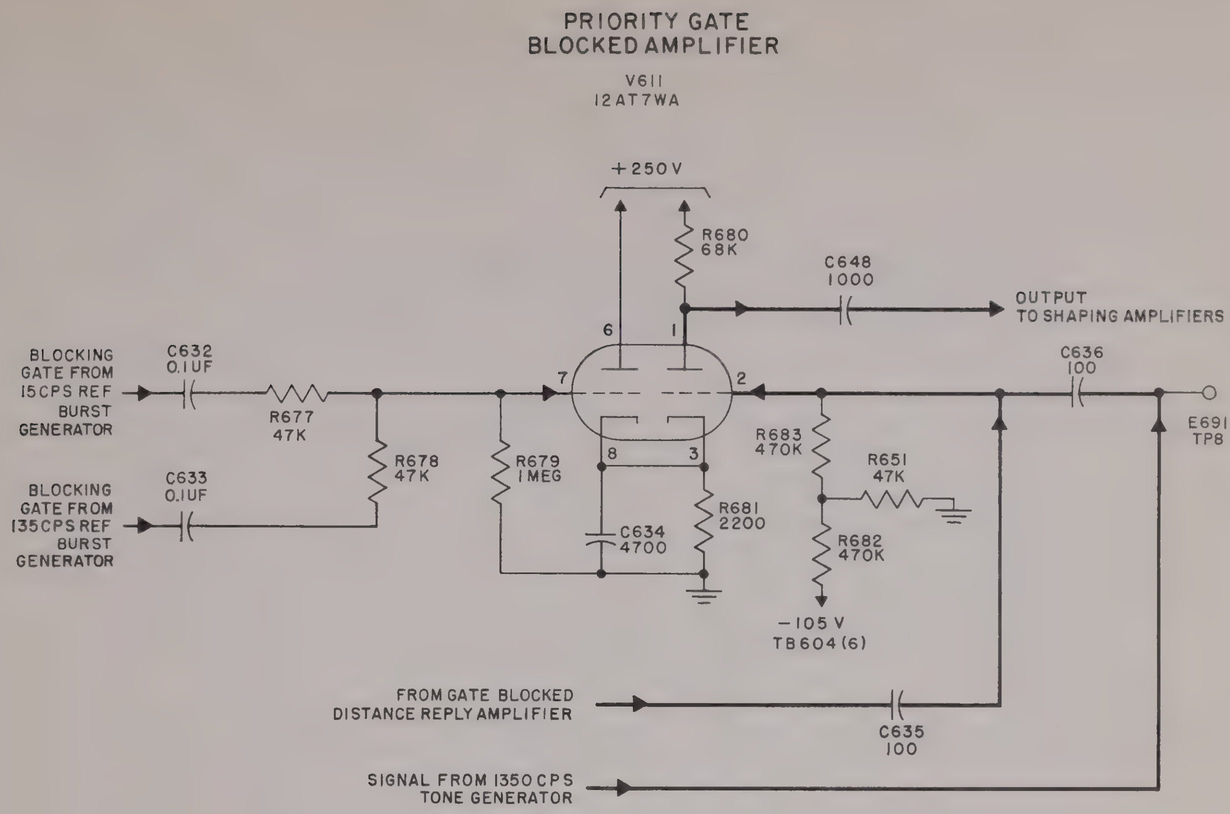


Figure 2-20. Coder-Indicator KY-235/URN, Gate-Blocked Priority Amplifier, Simplified Schematic Diagram

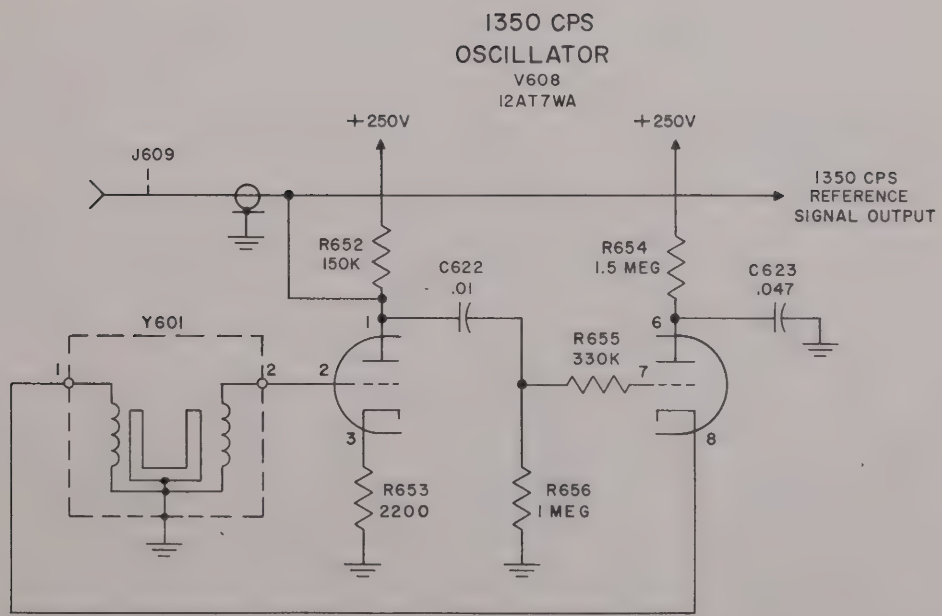


Figure 2-21 Coder-Indicator KY-235/URN, Antenna Synchronization 1350-CPS Oscillator, Simplified Schematic Diagram

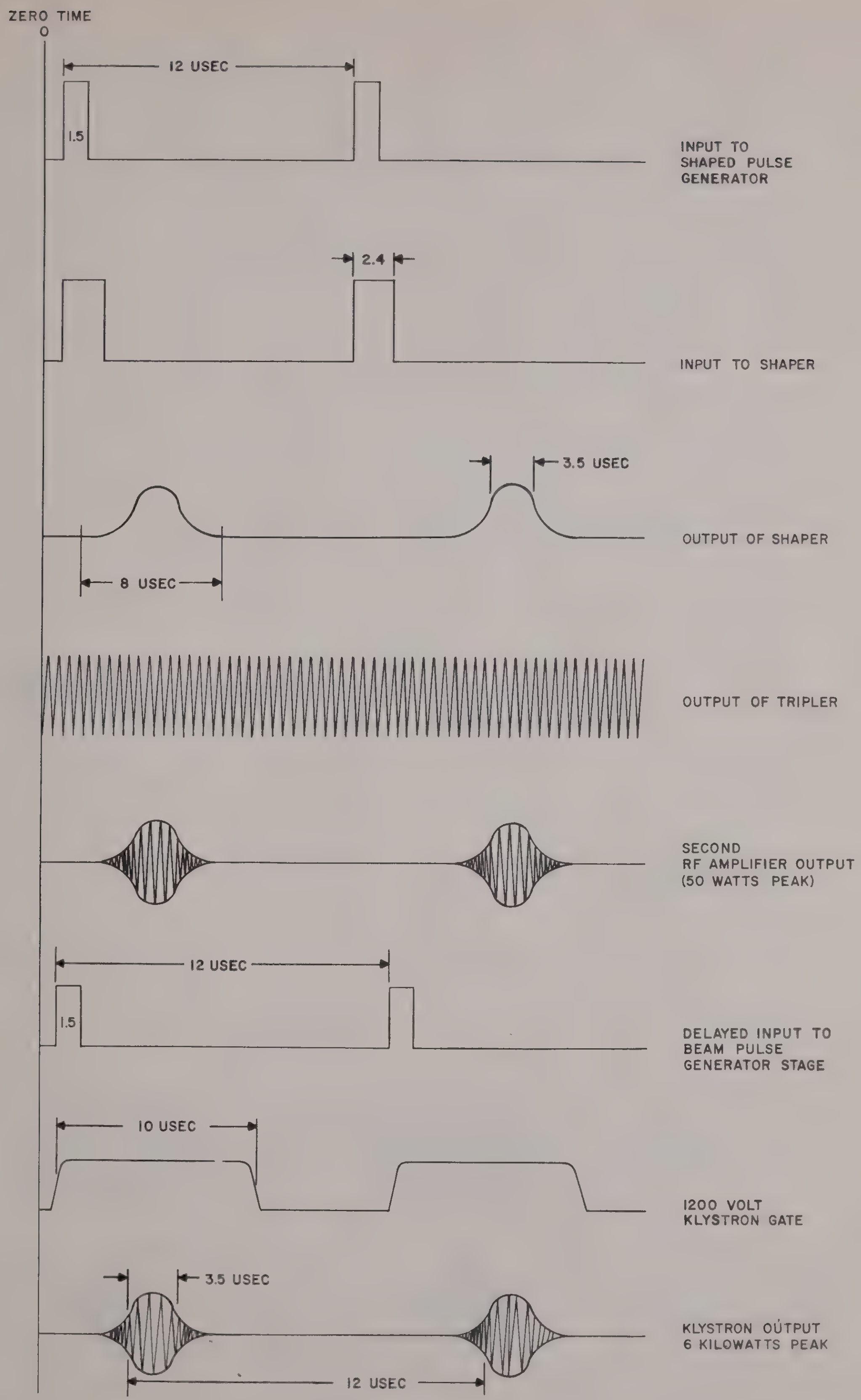


Figure 2-22. Radio Set AN/GRN-9, Transmitter Pulse Sequence

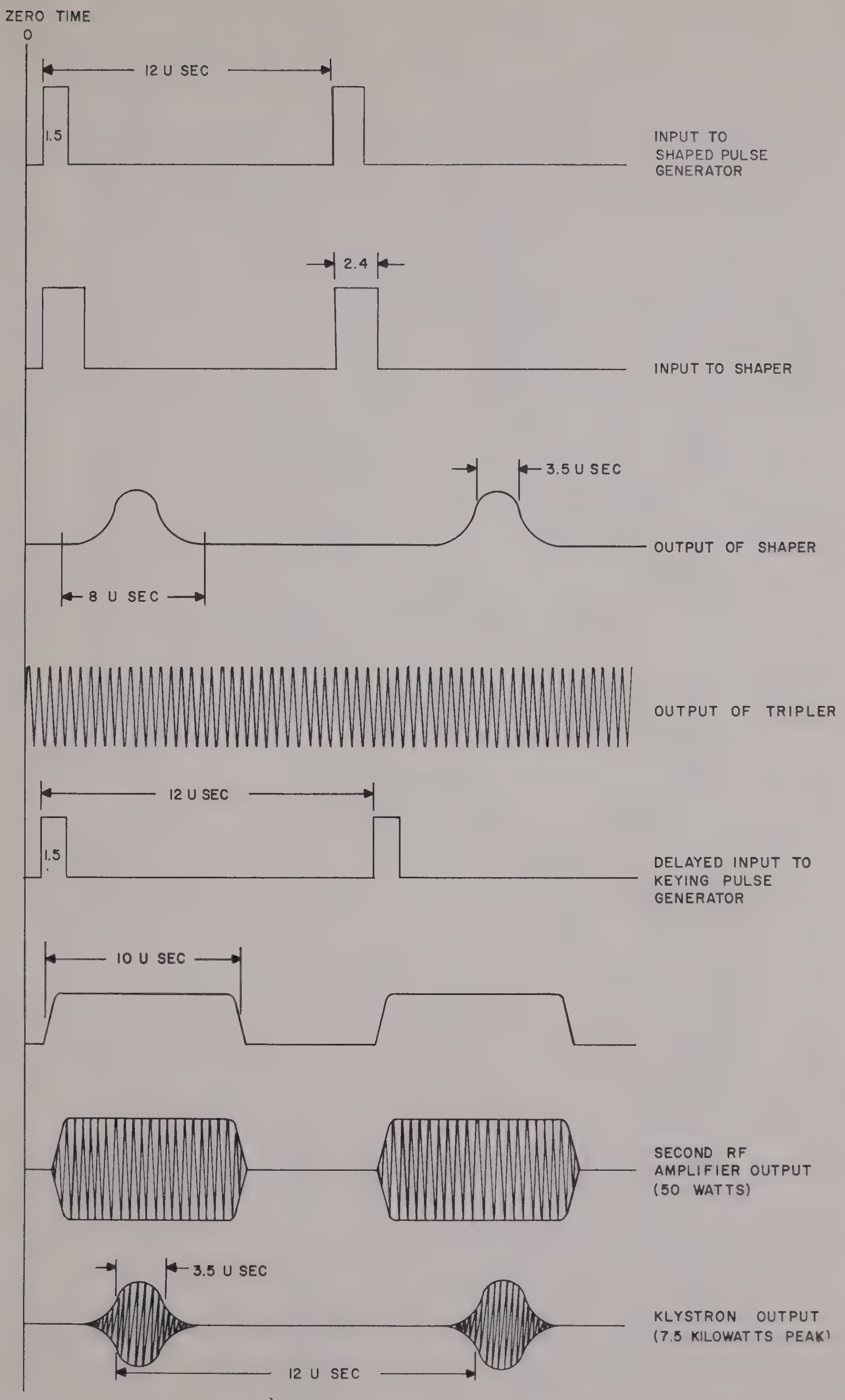


Figure 2-22.1. Radio Set AN/GRN-9A, Transmitter Pulse Sequence

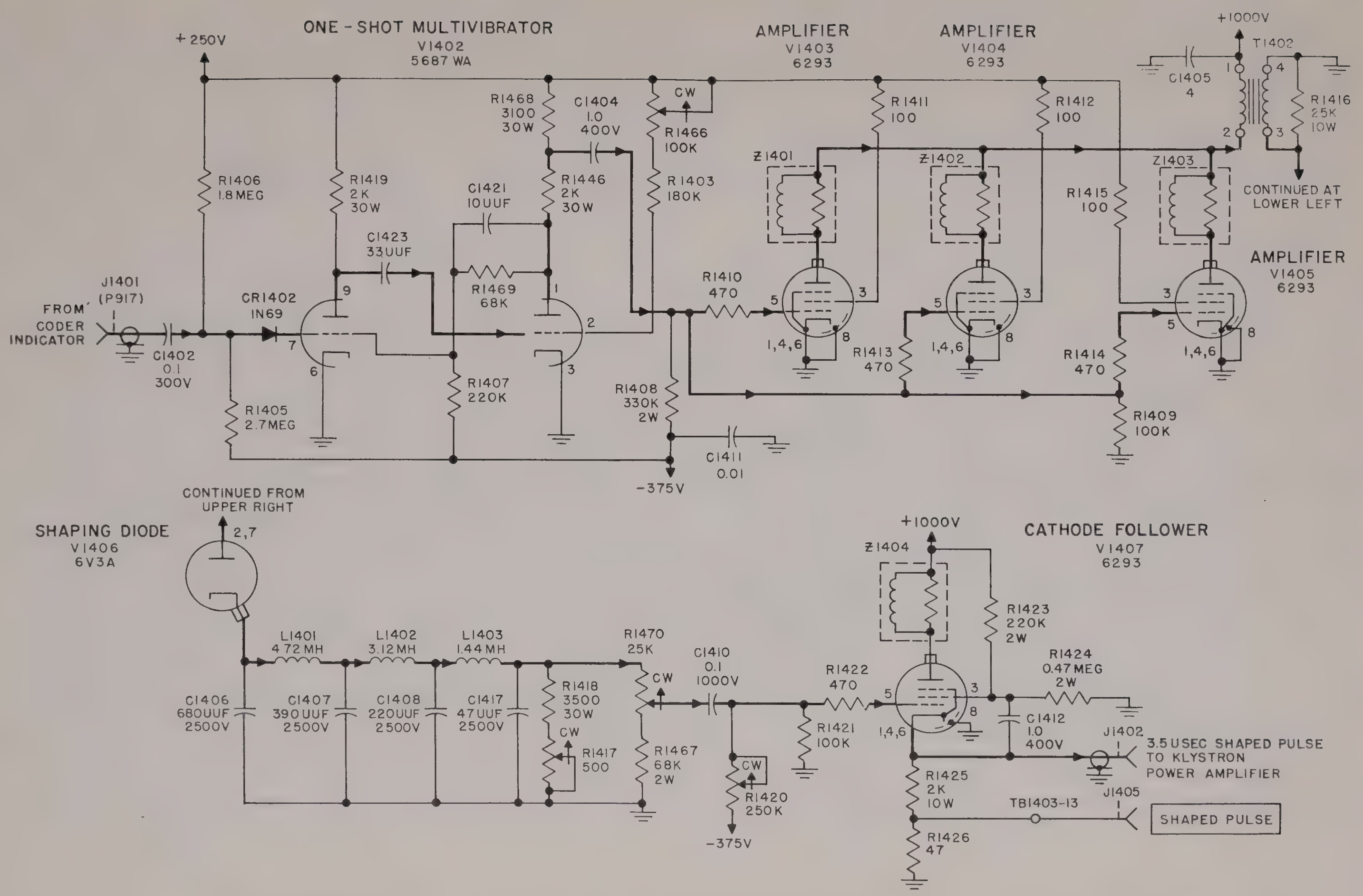


Figure 2-23. Frequency Multiplier-Oscillator CV-590/GRN-9, Shaped Pulse Generator, Simplified Schematic Diagram

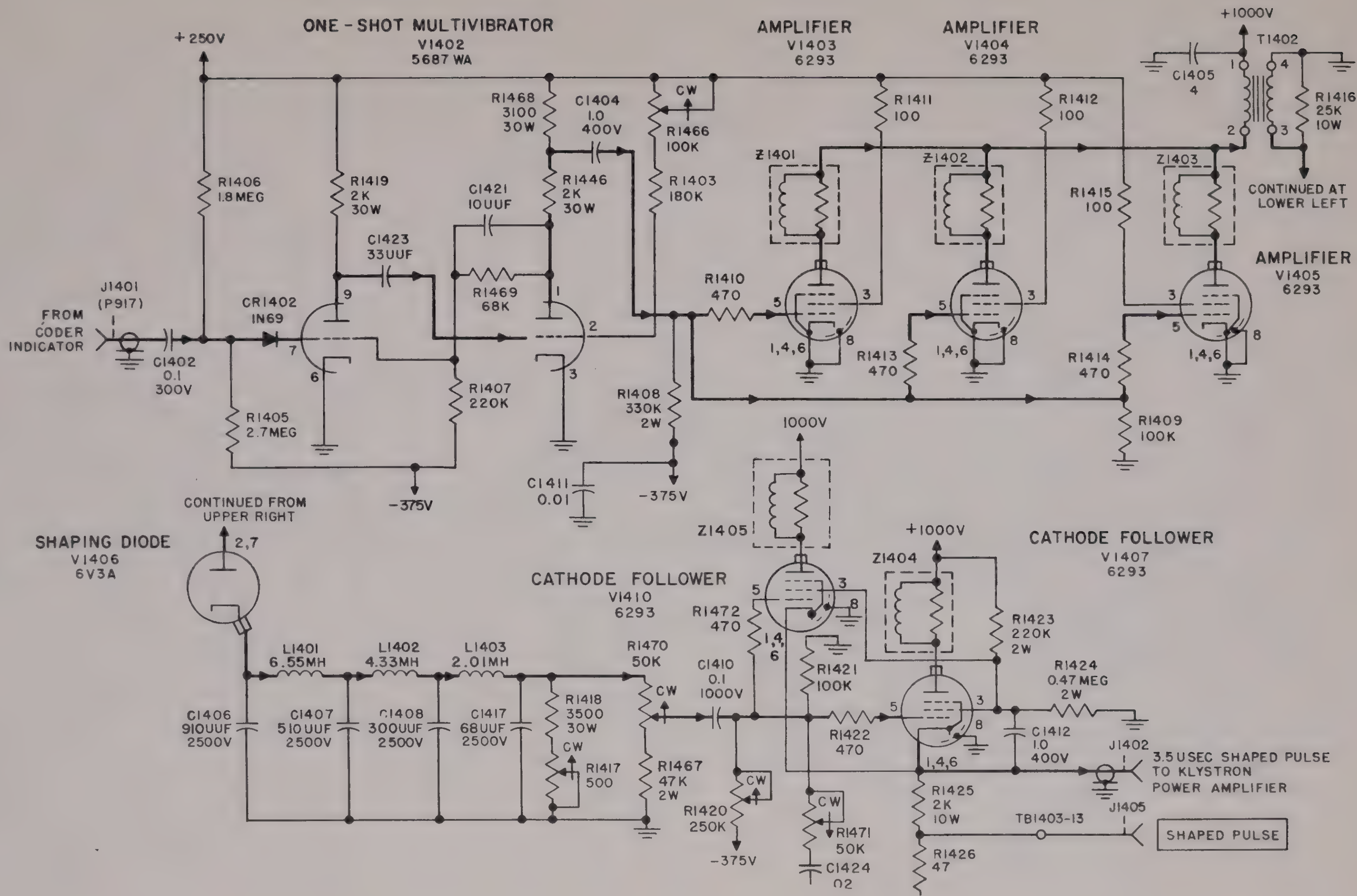


Figure 2-23. 1. Frequency Multiplier-Oscillator CV-589, Shaped Pulse Generator, Simplified Schematic Diagram

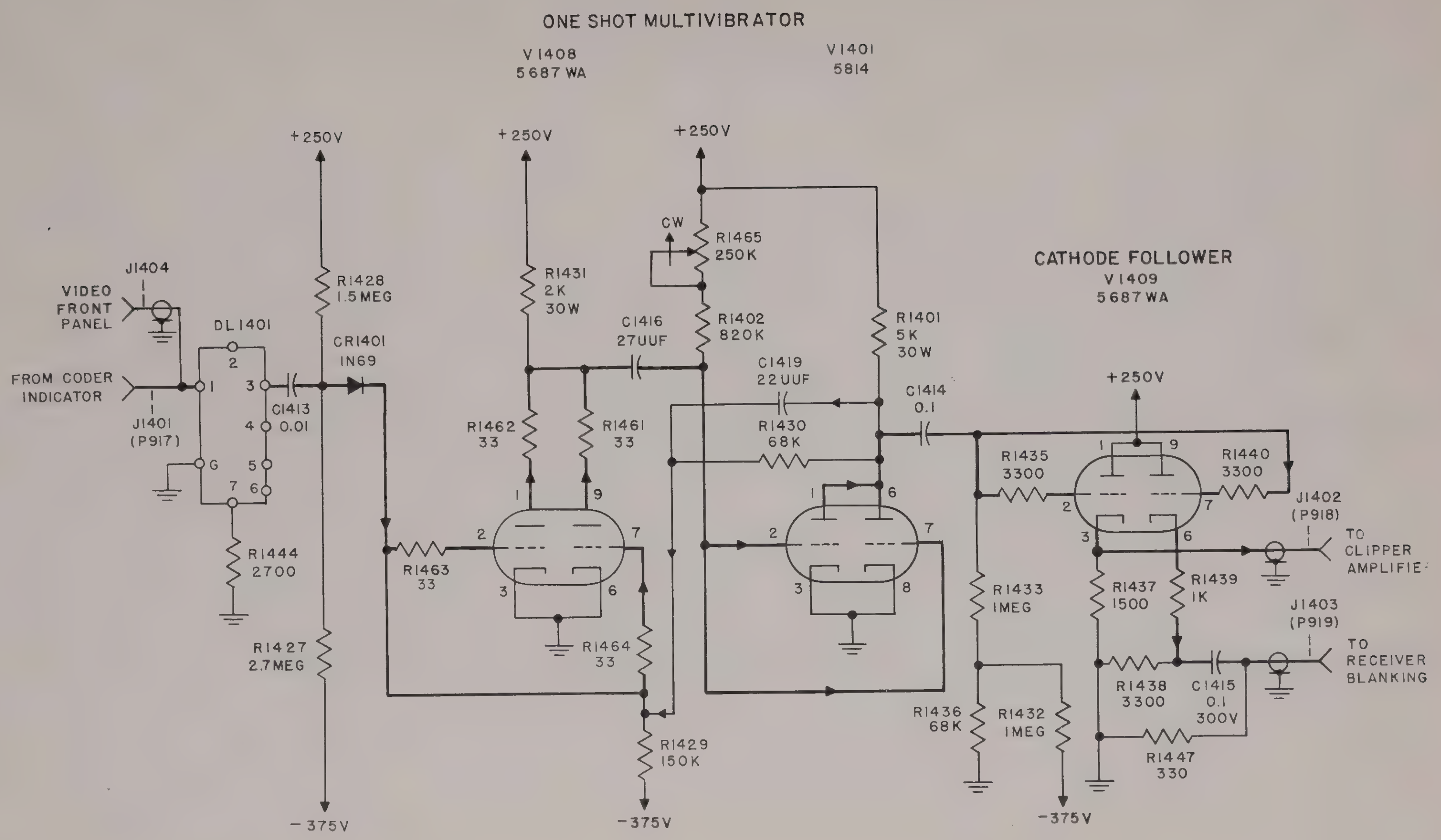


Figure 2-24. Frequency Multiplier-Oscillator CV-589, Gate Pulse Generator, Simplified Schematic Diagram

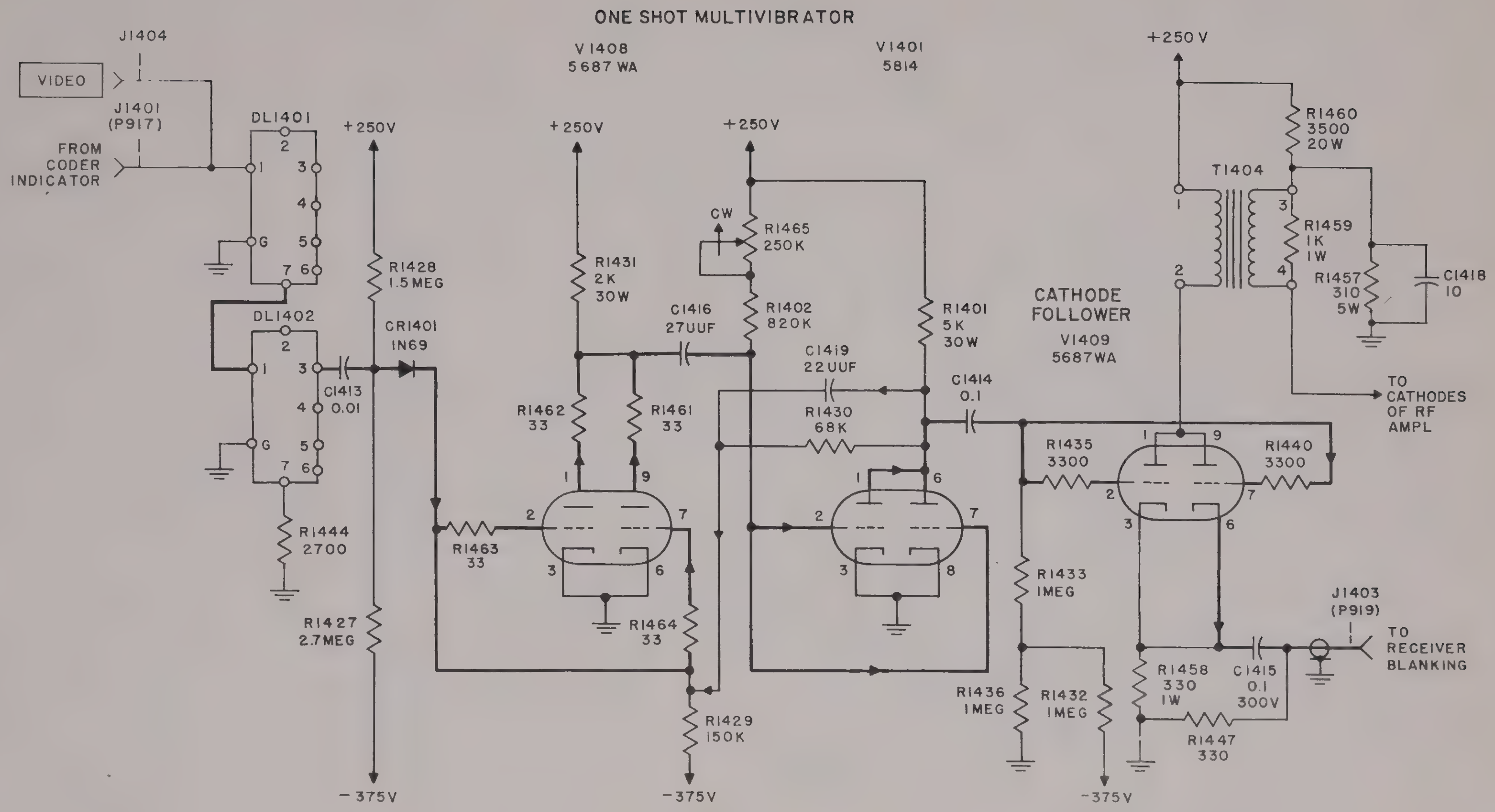


Figure 2-24. 1. Frequency Multiplier-Oscillator CV-589, Gate Pulse Generator, Simplified Schematic Diagram

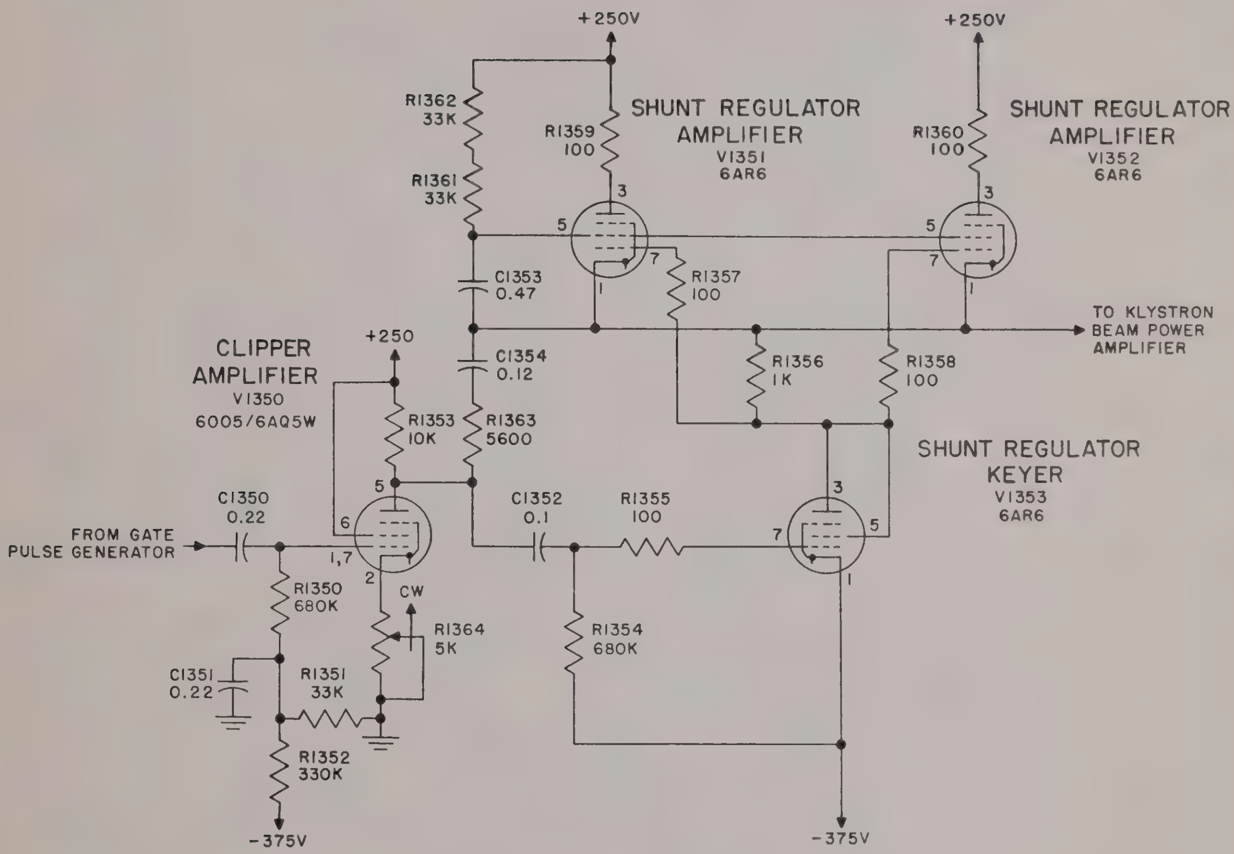


Figure 2-25. Amplifier-Modulator AM-1702/GRN-9, Clipper Amplifier and Shunt Regulator, Simplified Schematic Diagram

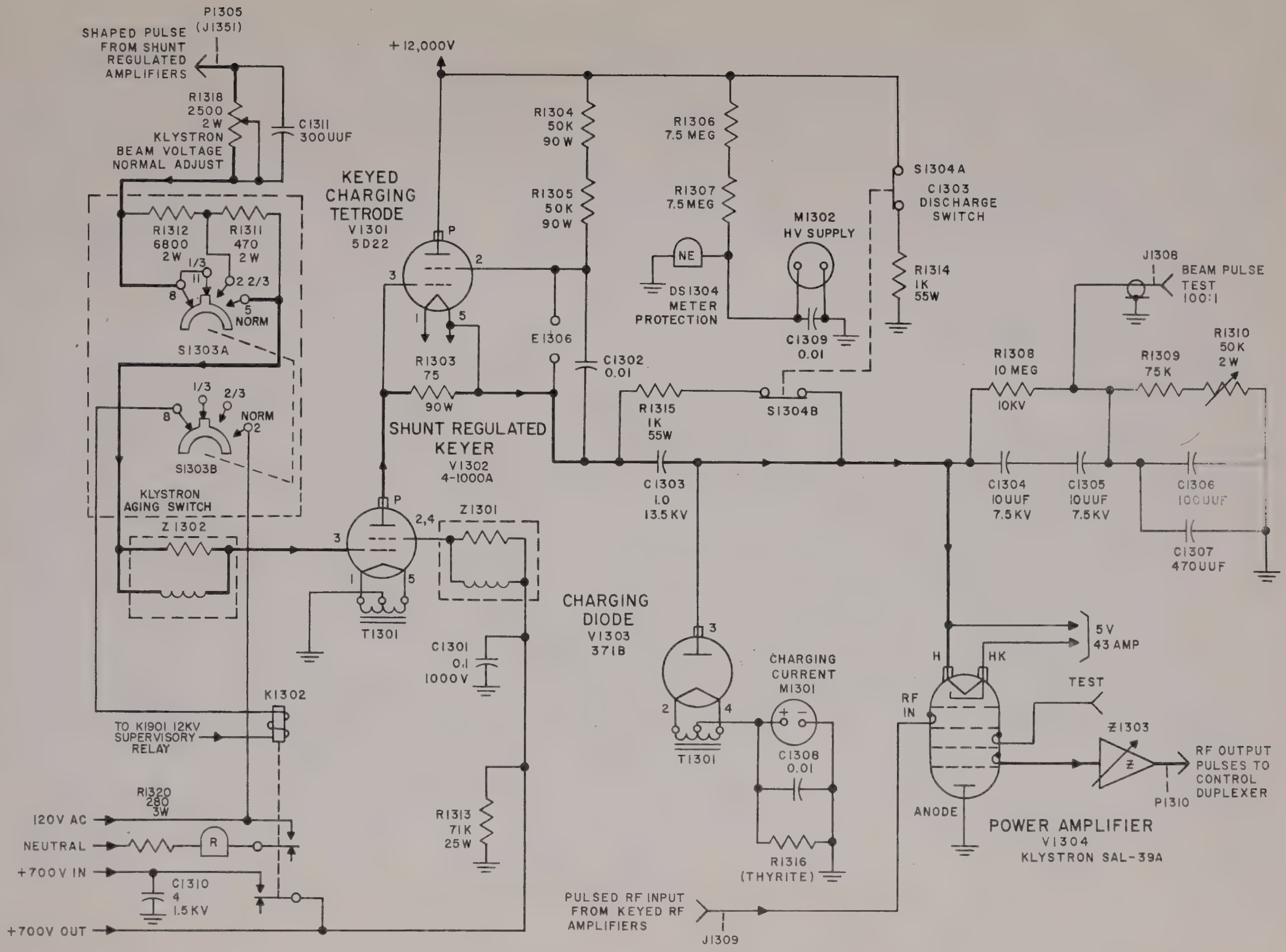


Figure 2-26. Radio Set AN/GRN-9, Transmitter Output Circuit, Simplified Schematic Diagram

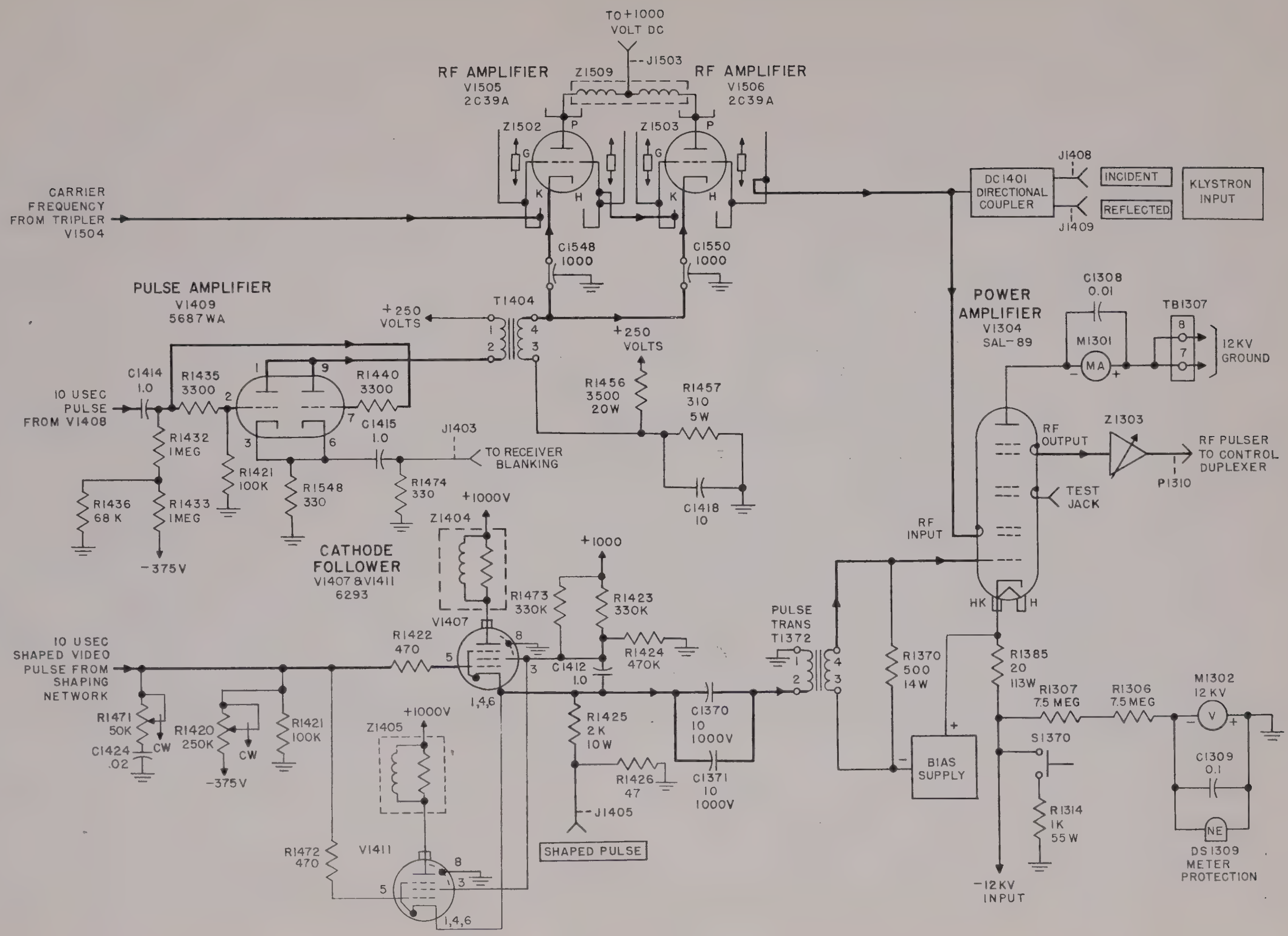


Figure 2-26.1. Radio Sets AN/GRN-9A and AN/SRN-6, Transmitter Output Circuit, Simplified Schematic Diagram

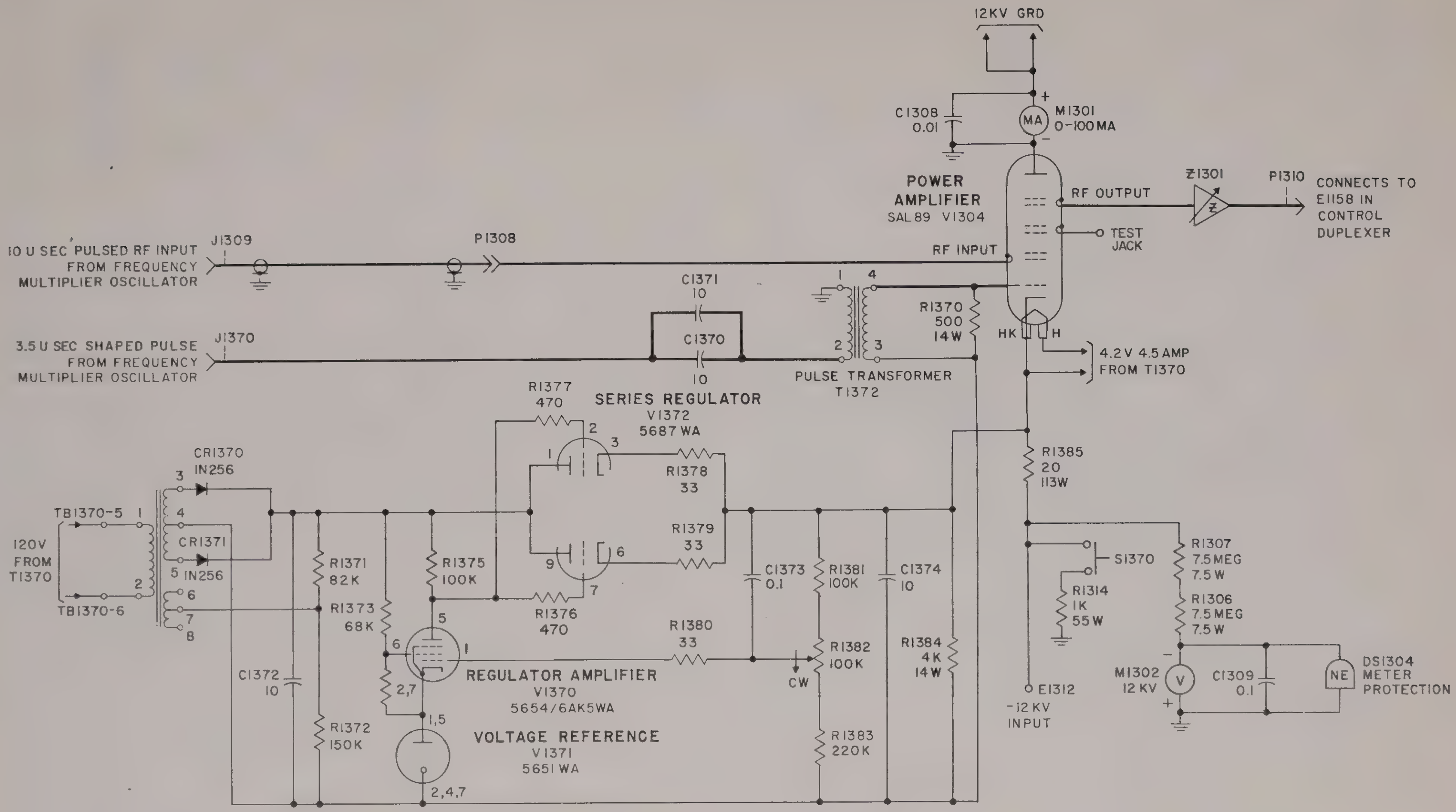


Figure 2-26. 2. Amplifier-Modulator AM-1701/URN, Simplified Schematic Diagram

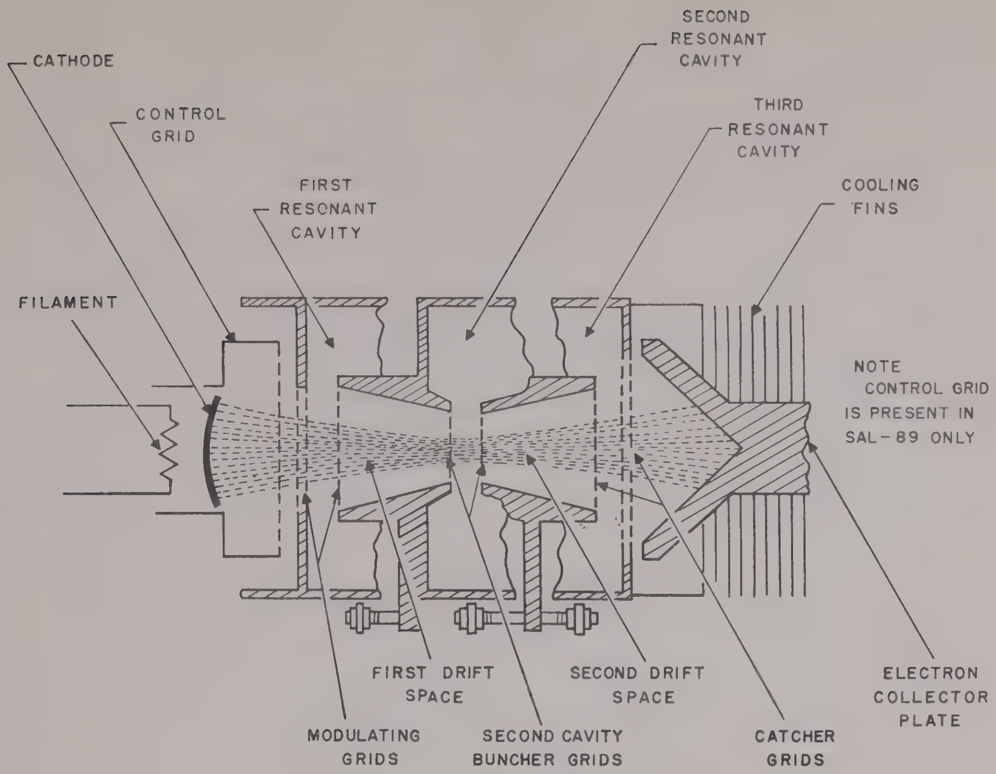


Figure 2-27. Klystron Sectional Diagram

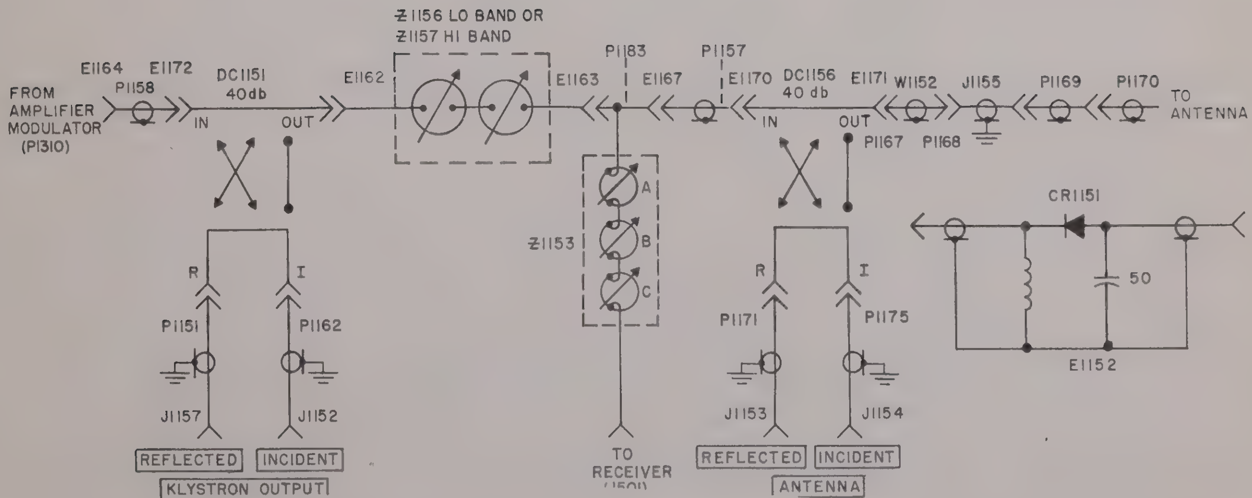


Figure 2-28. Control-Duplexer C-2225/SRN-6 and CV-2226, Duplexer Functional Schematic

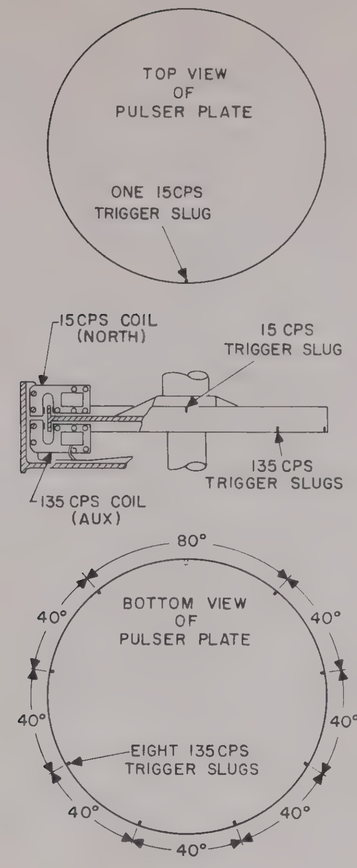


Figure 2-29.1 Radio Beacon Reference Burst Trigger Pulse Generator

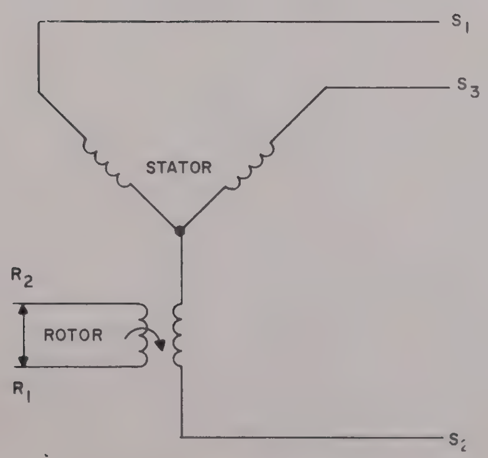


Figure 2-29. 2. Synchro Transmitter, Synchro Receiver, or Synchro Control Transformer, Schematic Diagram

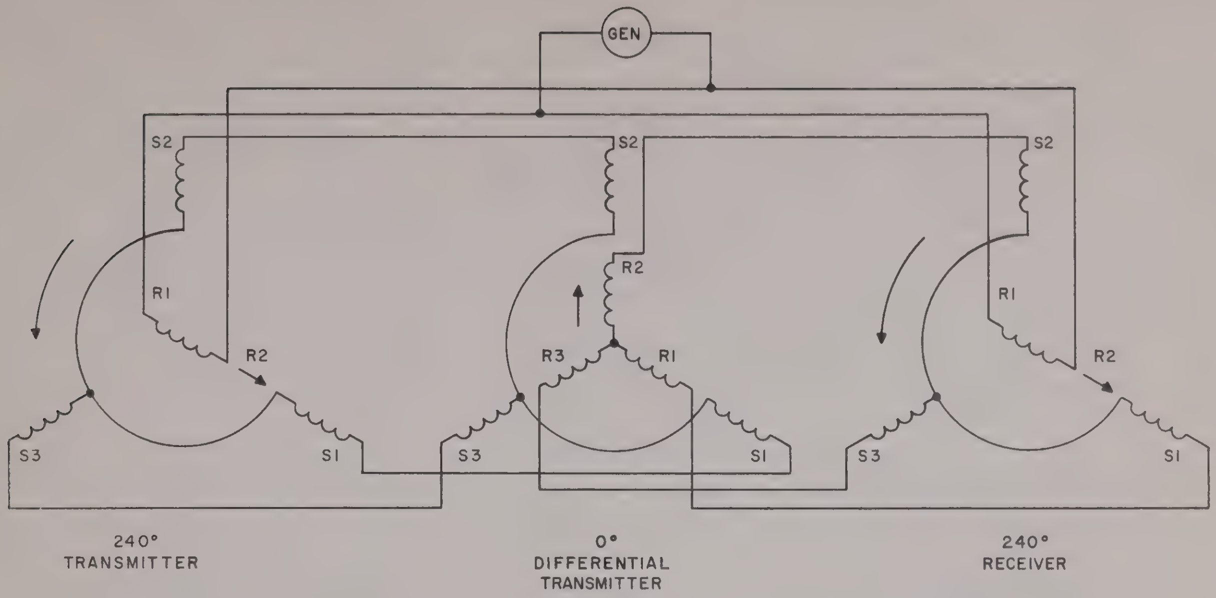


Figure 2-29. 3. Differential Synchro at 0° Shown Connected to Synchro Transmitter at 240°

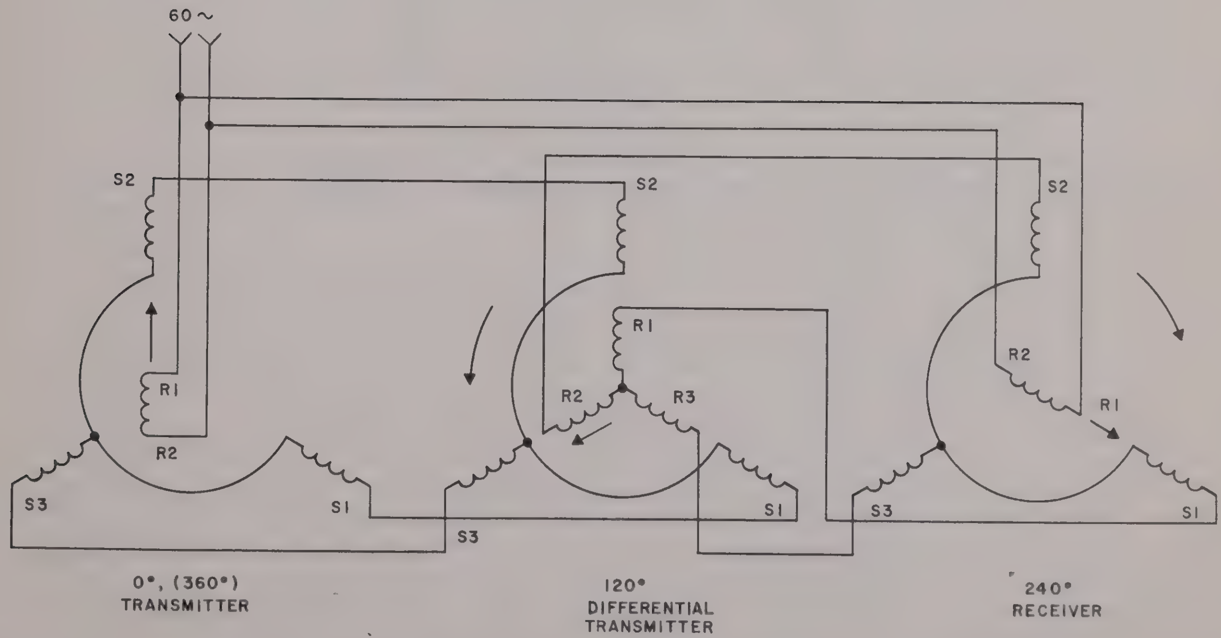


Figure 2-29. 4. Differential Synchro at 120° Connected to Synchro Transmitter and Receiver at 240°

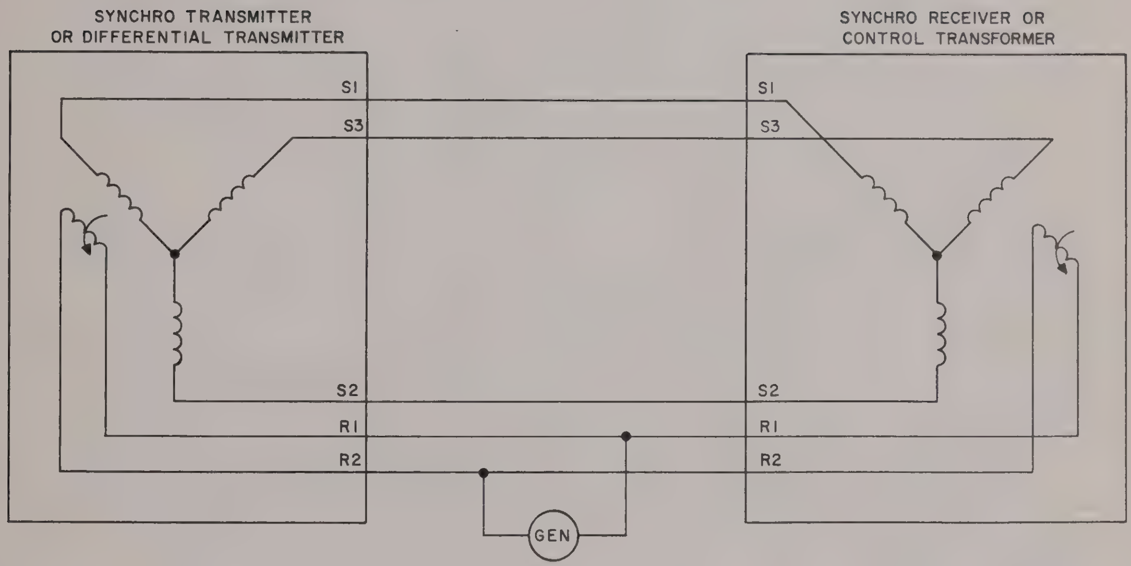


Figure 2-29. 5. Synchro Transmitter and Receiver Connected in Parallel

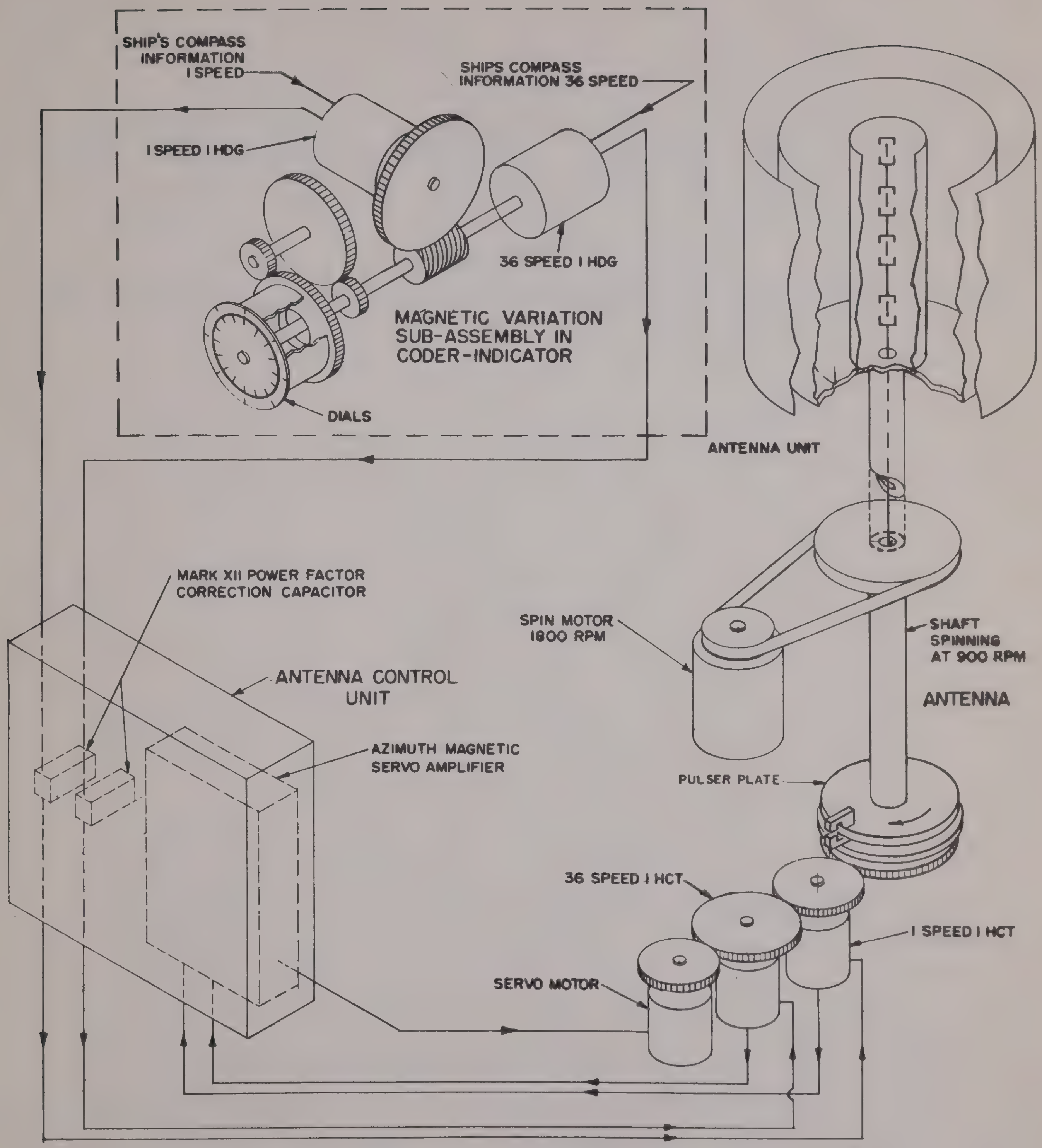


Figure 2-29.6. Shipboard Bearing Servo System, Functional Diagram

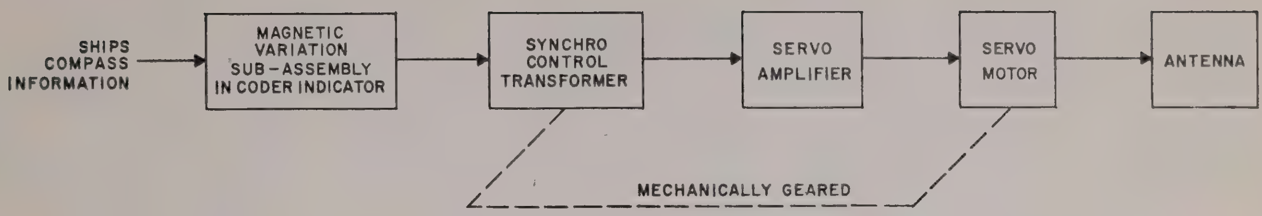


Figure 2-29. 7. Shipboard Bearing Servo System, Simplified Block Diagram

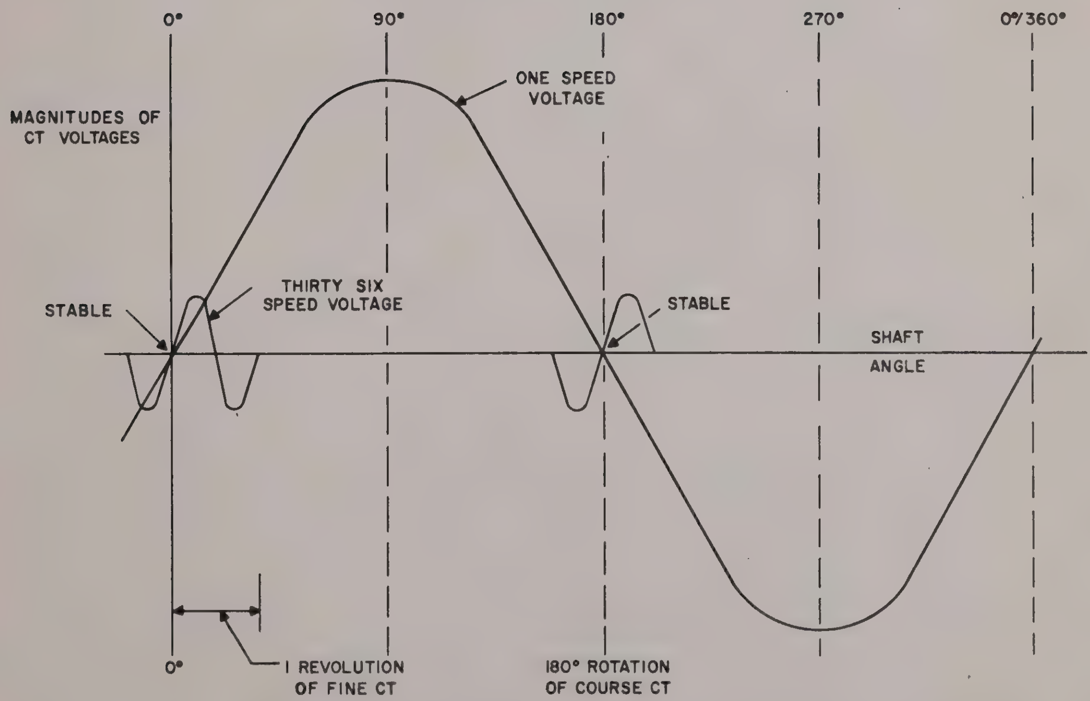


Figure 2-29. 8. Pure 1-Speed and 36-Speed Control Transformer Output Voltages, without Antistickoff Voltage

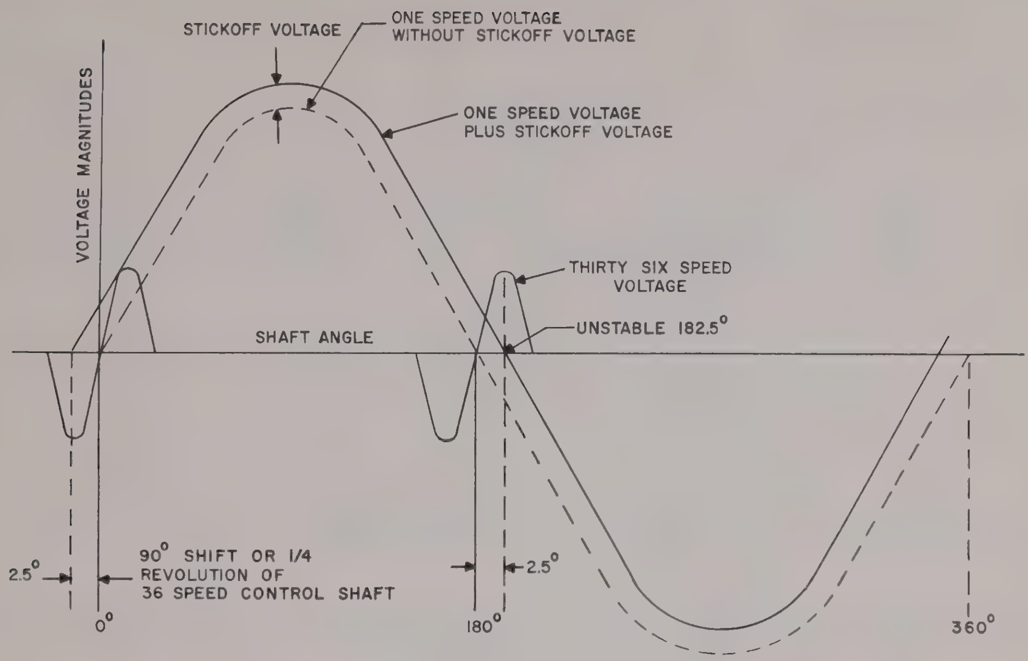


Figure 2-29. 9. One-Speed and 36-Speed Synchro Output Voltages, Antistickoff Voltage Shown Added

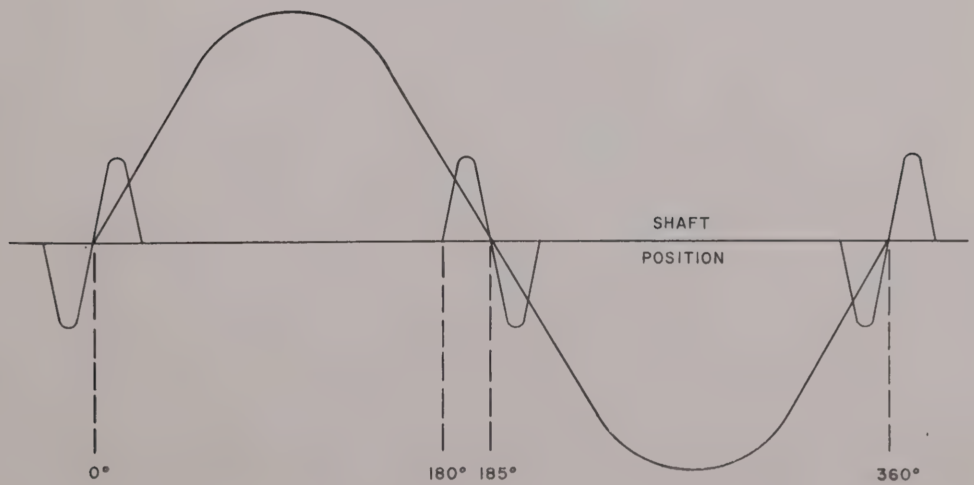


Figure 2-20. 10. Final Form of 1-Speed and 36-Speed Synchro Output Voltages

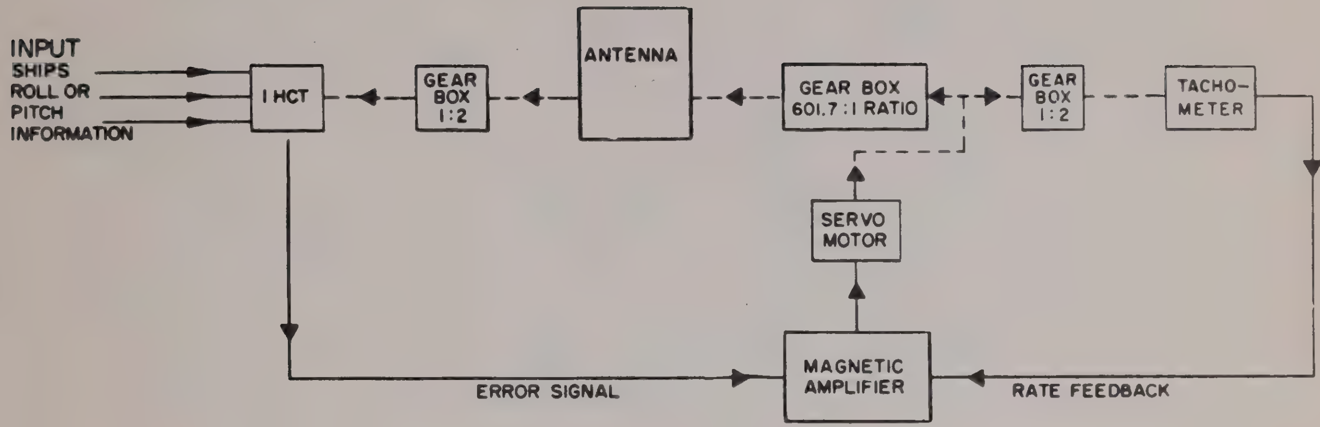


Figure 2-29.11. Pitch and Roll Servo System, Shipboard Antenna Group, Block Diagram

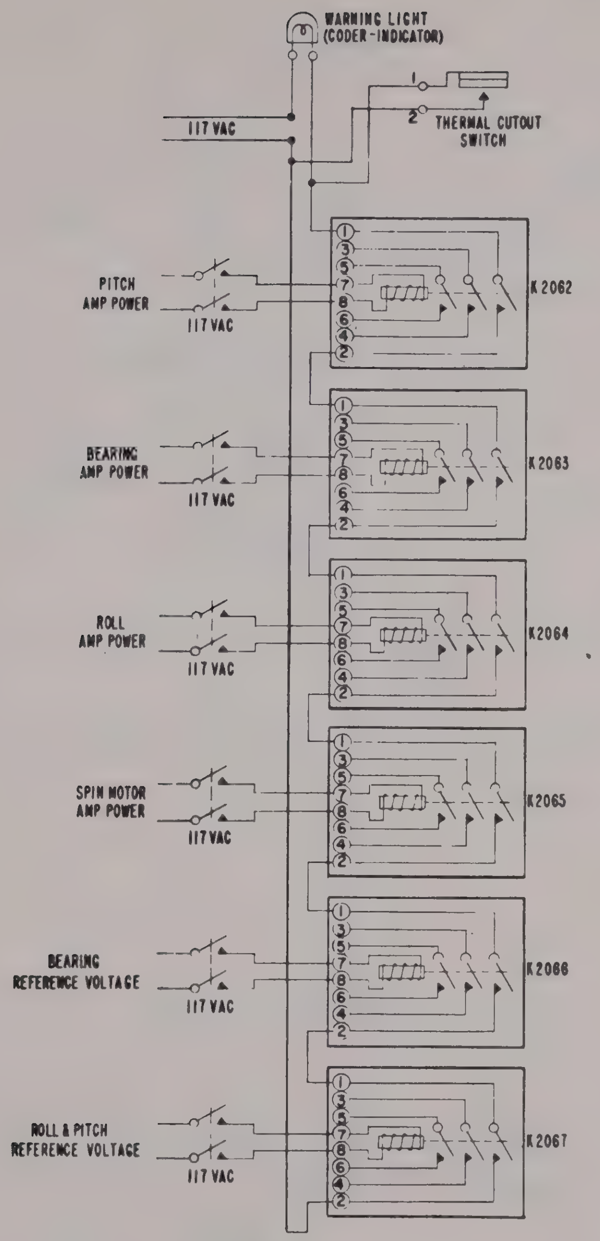


Figure 2-29.12. Shipboard Antenna Group OA-1545/SRN-6, Warning Light Circuit, Schematic Diagram

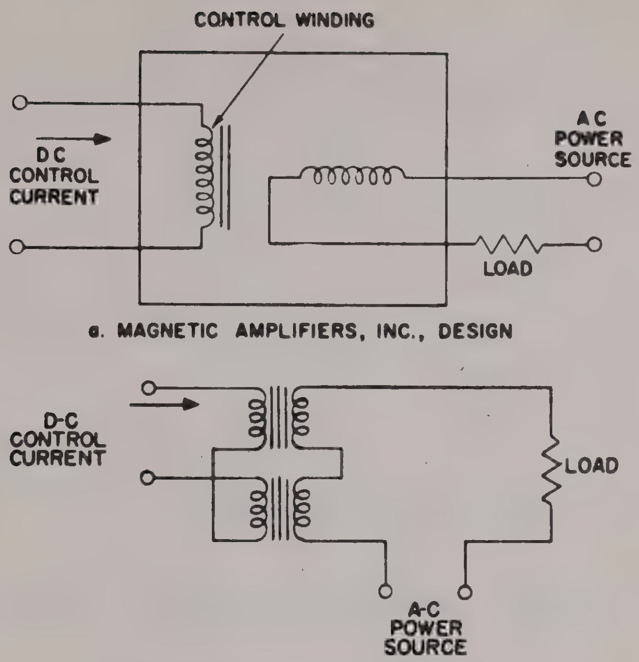


Figure 2-29.13. Simple Saturable Reactor Circuits, Schematic Diagram

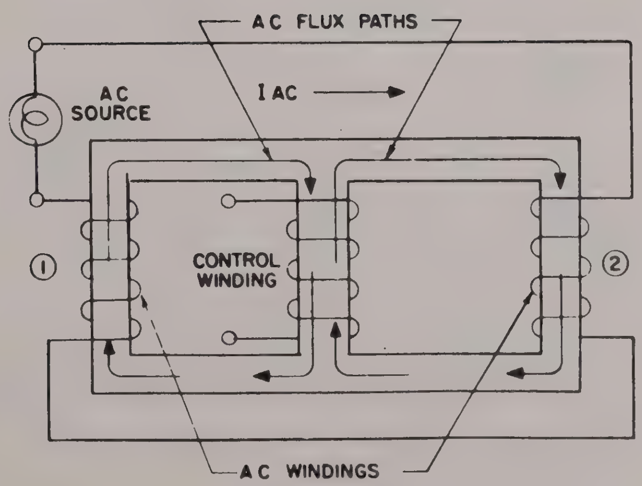


Figure 2-29.14. Simple Saturable Reactor Arranged to Eliminate Induced AC in Control Winding

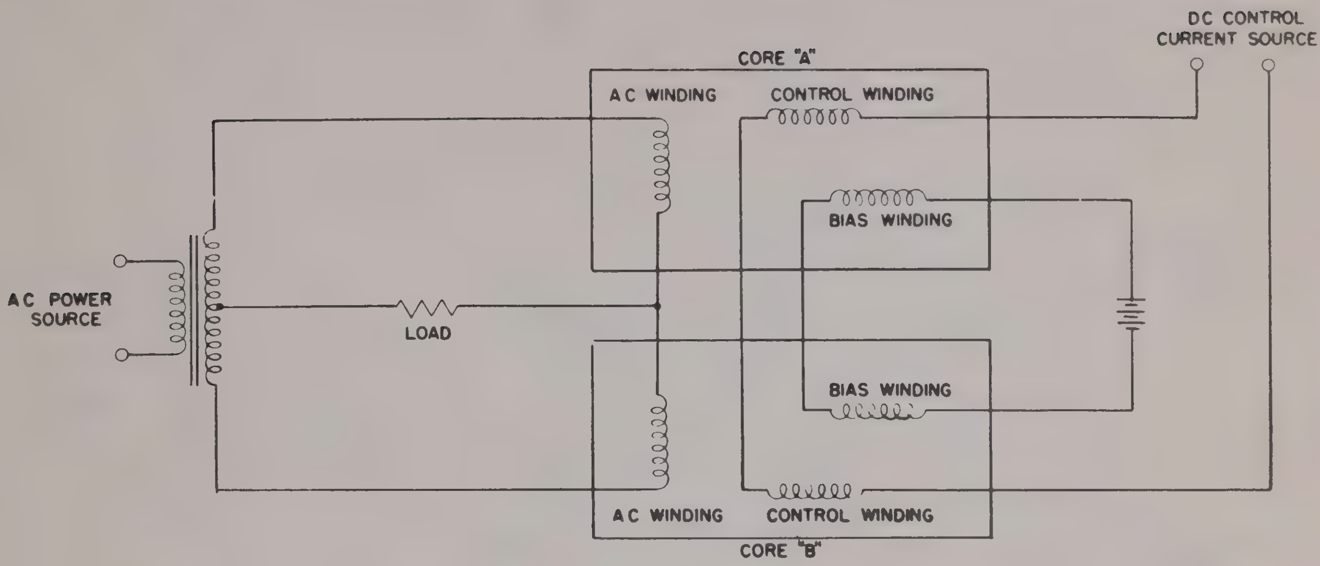


Figure 2-29.15. Balanced Magnetic Amplifier, Schematic Diagram

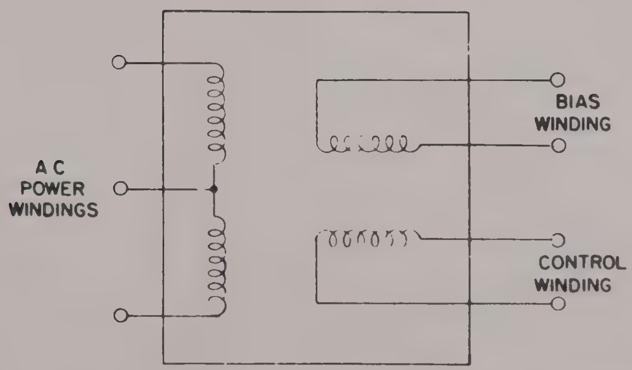


Figure 2-29.16. Balanced Saturable Reactor, Simplified Schematic Diagram

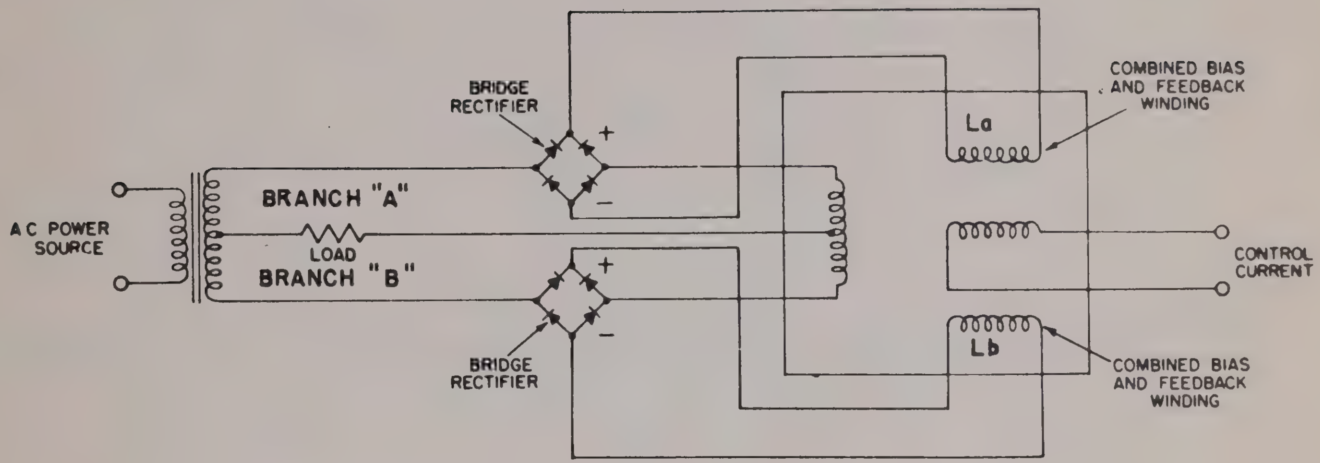


Figure 2-29.17. Balanced Saturable Reactor with Feedback, Schematic Diagram

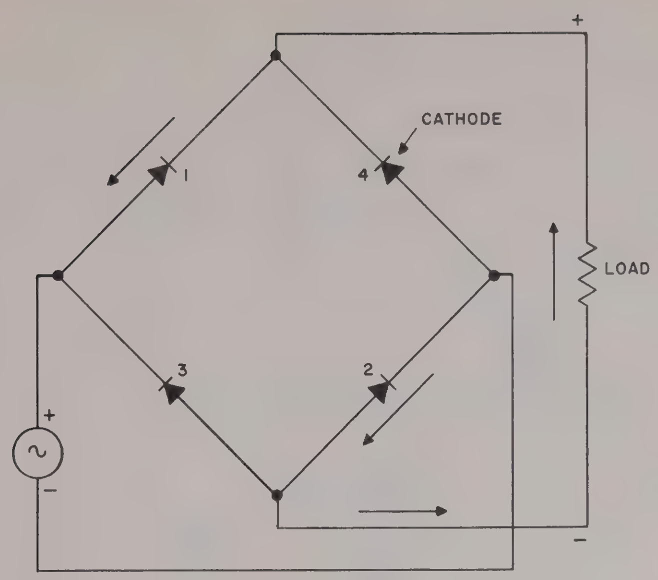


Figure 2-29. 18A. Bridge Rectifier Circuit Showing Direction of Load Current During Positive Half-cycle

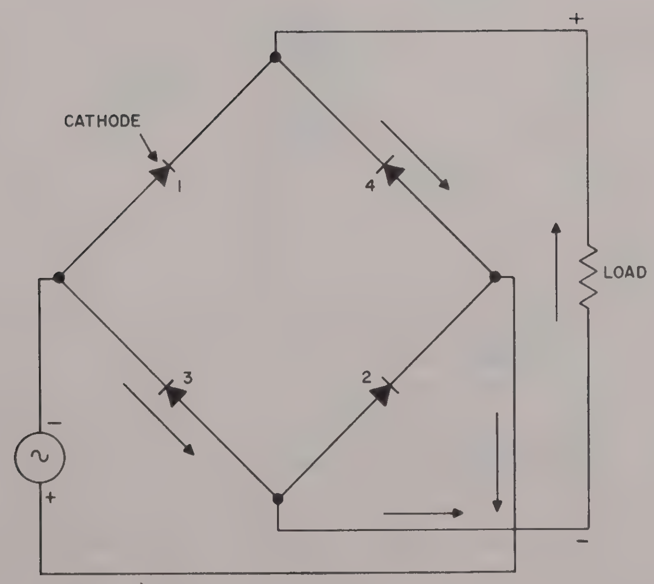
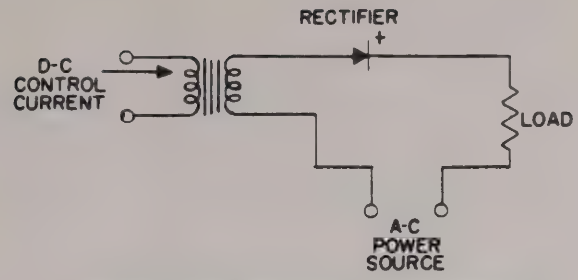
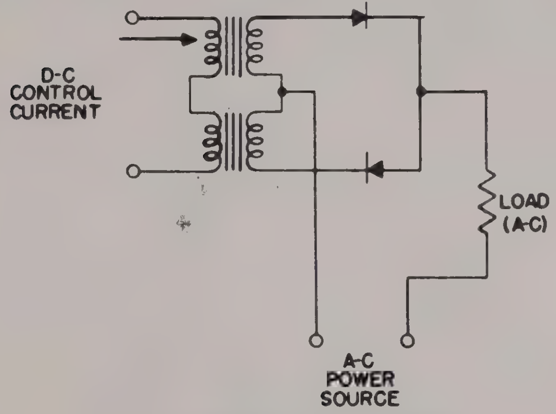


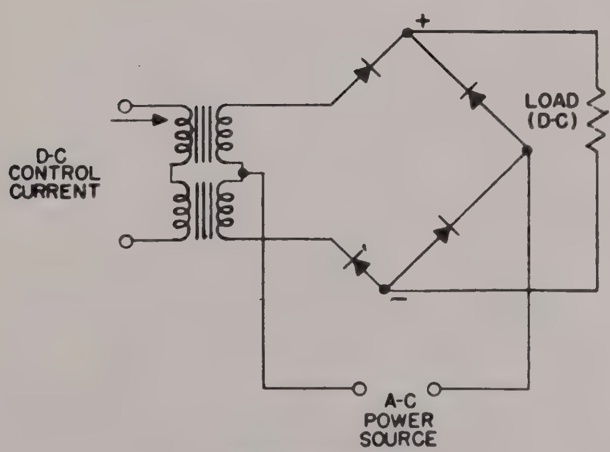
Figure 2-29-18B. Bridge Rectifier Circuit Showing Direction of Load Current During Negative Half-cycle



a. SIMPLEST FORM, HALF-CYCLE LOAD CURRENT



b. FULL-WAVE OUTPUT FORM



c. BRIDGE RECTIFIER

Figure 2-29.19. Self-Saturating Reactor Circuits, Schematic Diagrams

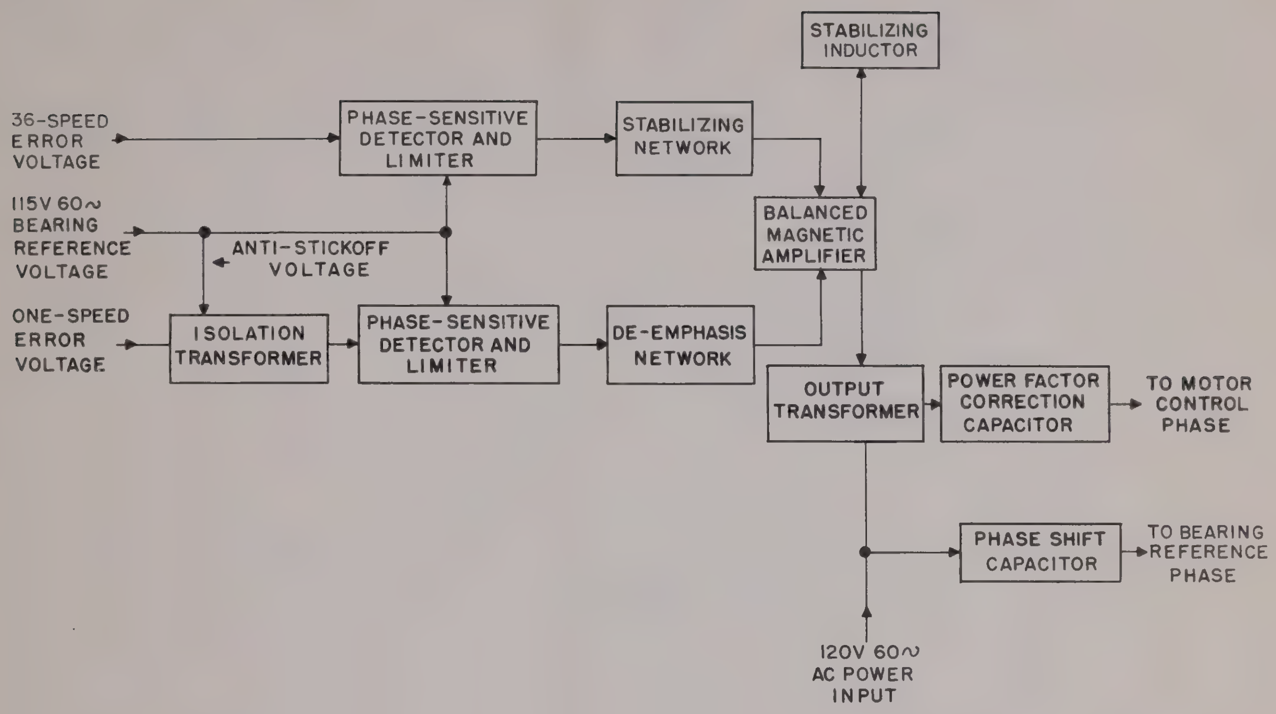


Figure 2-29. 20. Bearing Amplifier, Block Diagram

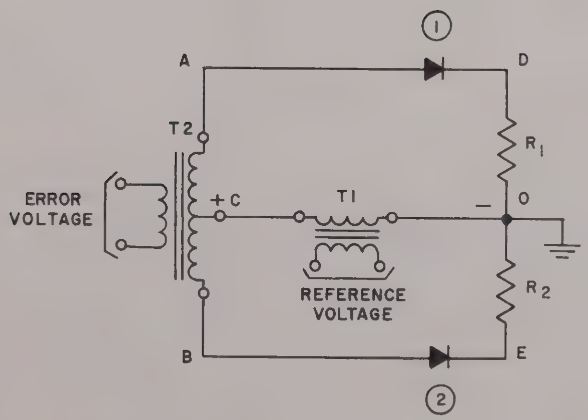


Figure 2-29. 21. Simple Phase-Sensitive Detector, Schematic Diagram

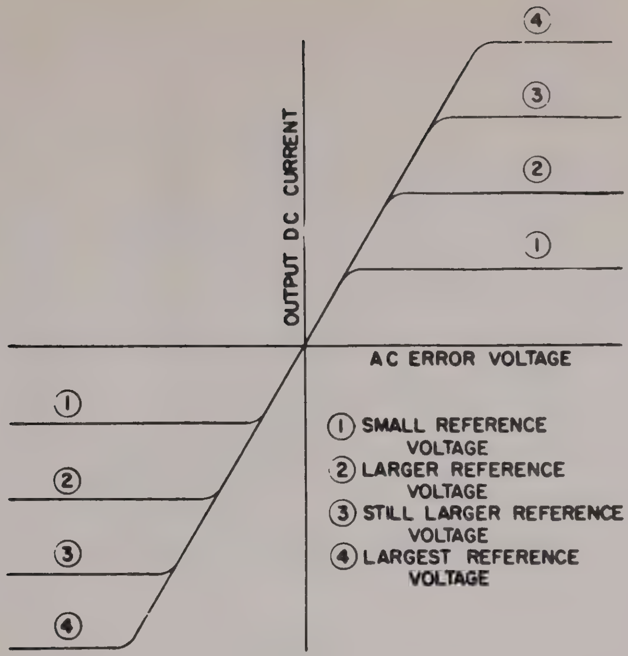


Figure 2-29.22. Comparison of Input AC Error with DC Output, Graphic Analysis

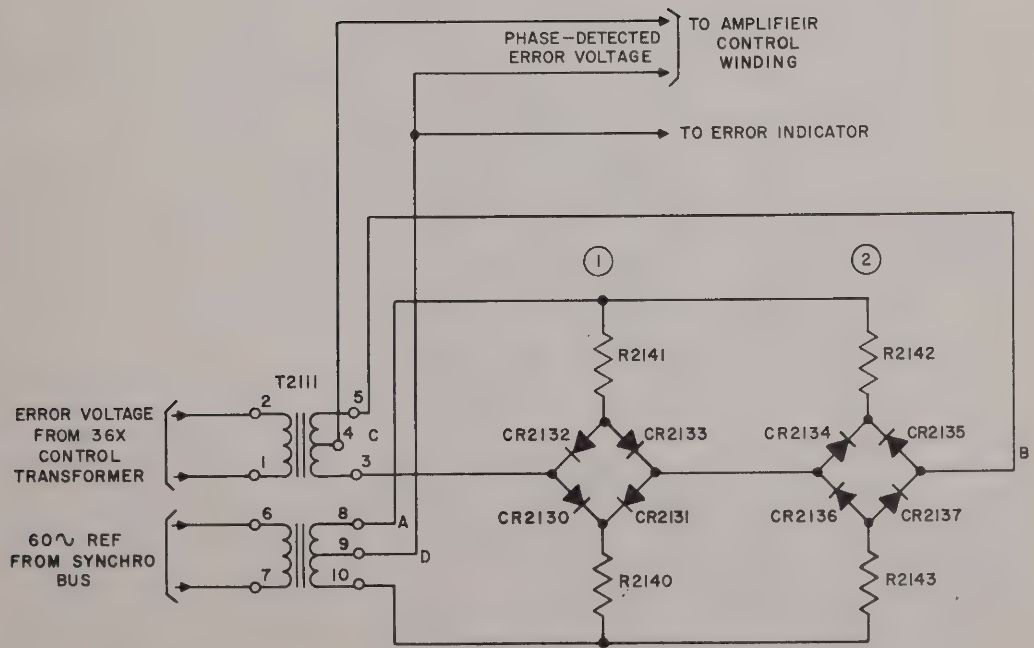


Figure 2-29.23. 36-Speed Phase-Sensitive Detector, Simplified Schematic Diagram

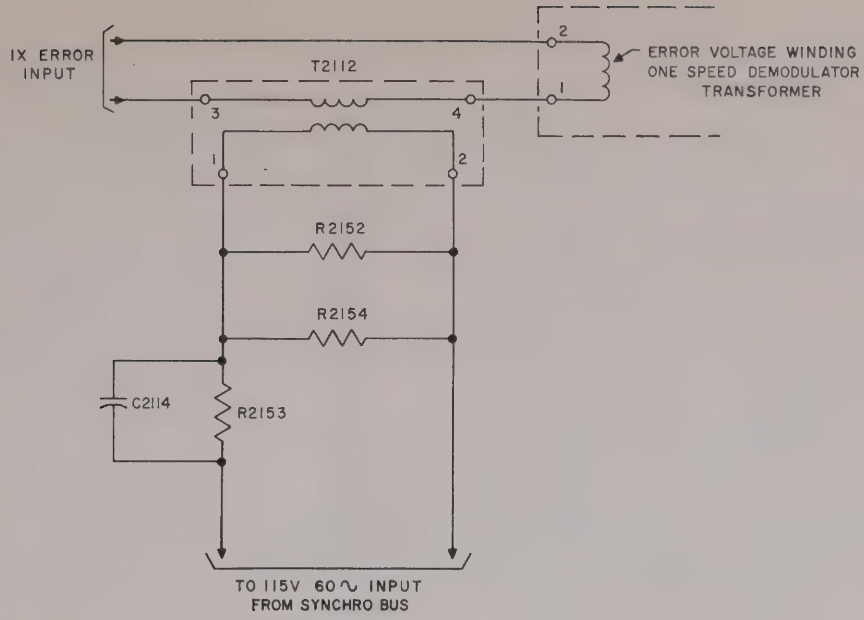


Figure 2-29. 24. Method of Adding Antistickoff Voltage

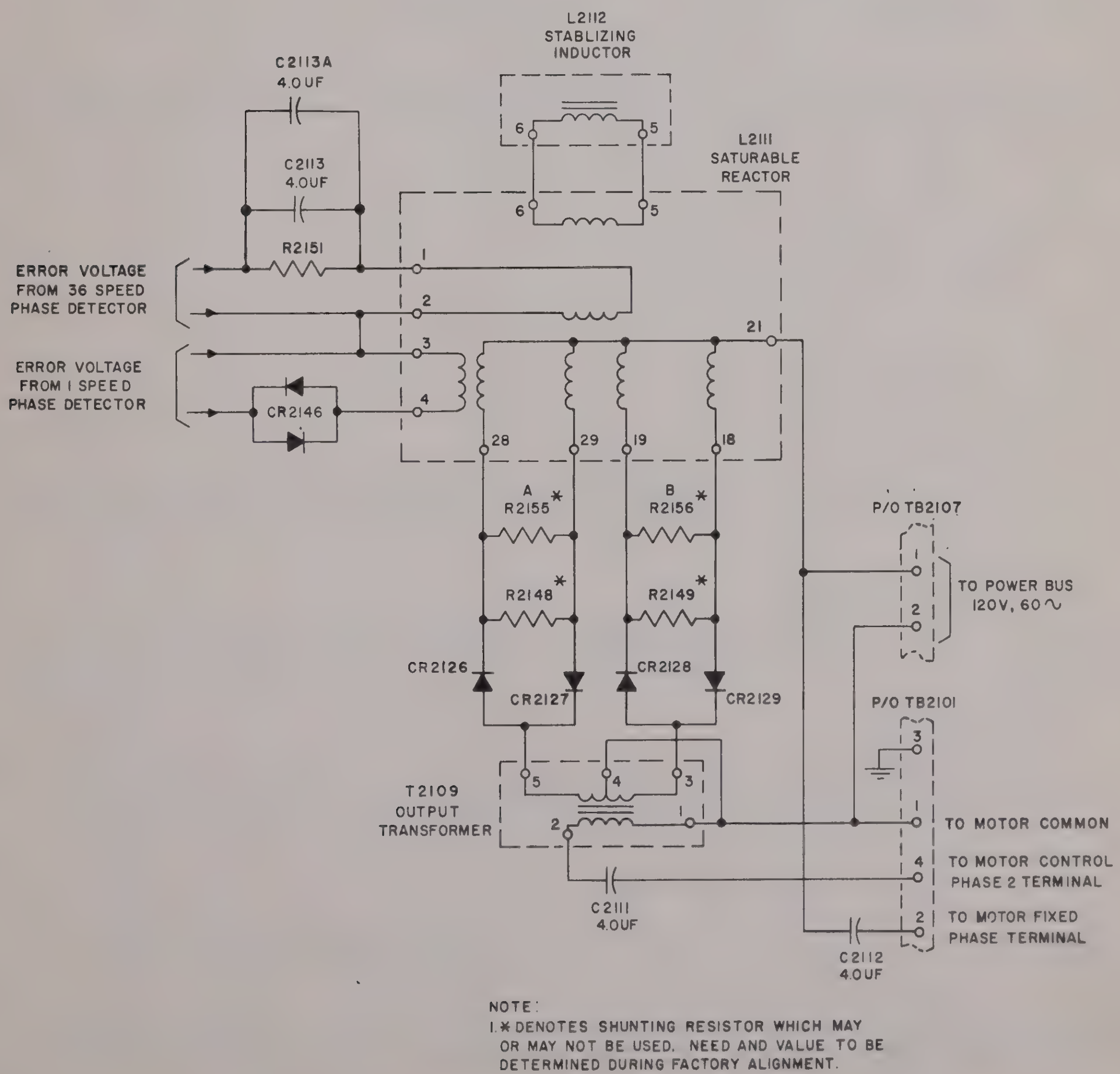


Figure 2-29. 25. Balanced Bearing Magnetic Amplifier, Schematic Diagram

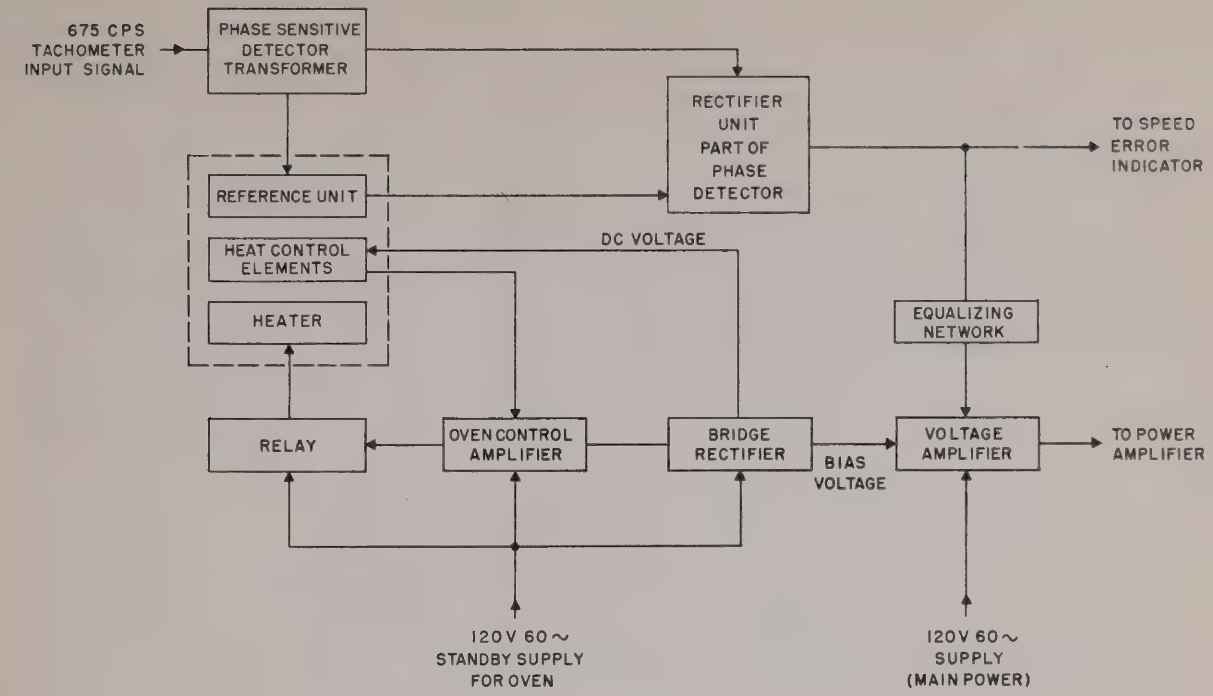


Figure 2-29. 26. Speed Control Preamplifier, Simplified Block Diagram

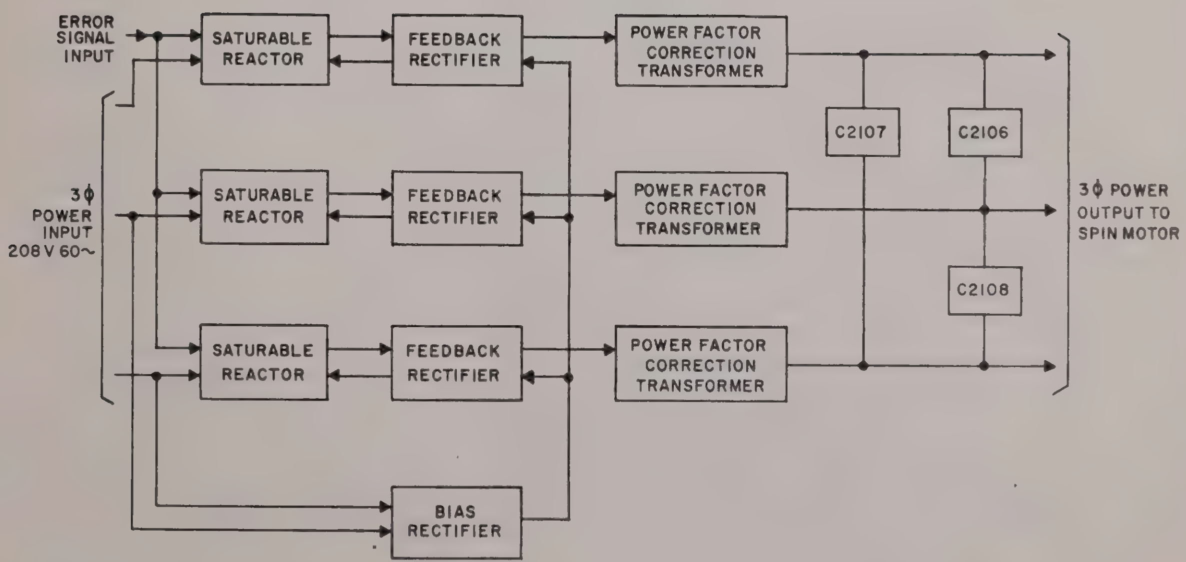


Figure 2-29. 27. Speed Control Power Amplifier, Block Diagram

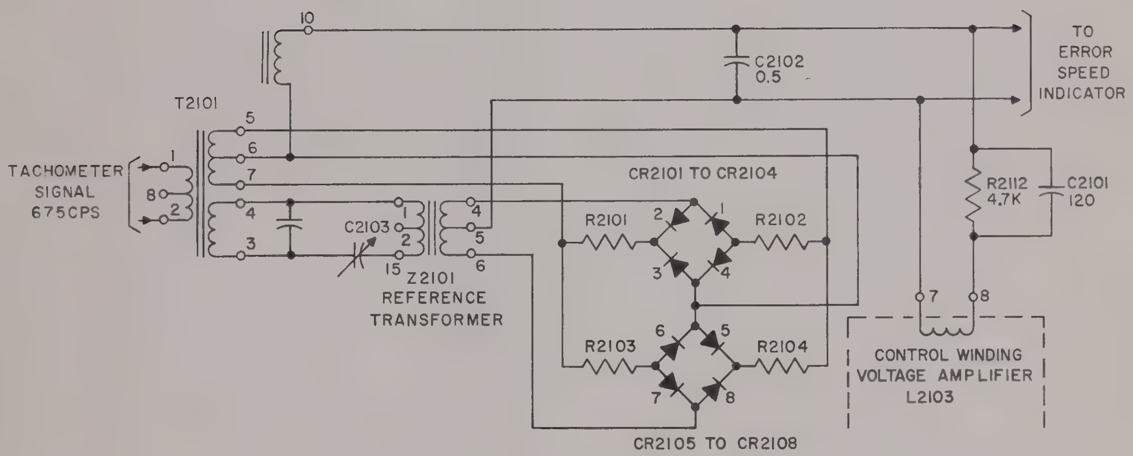
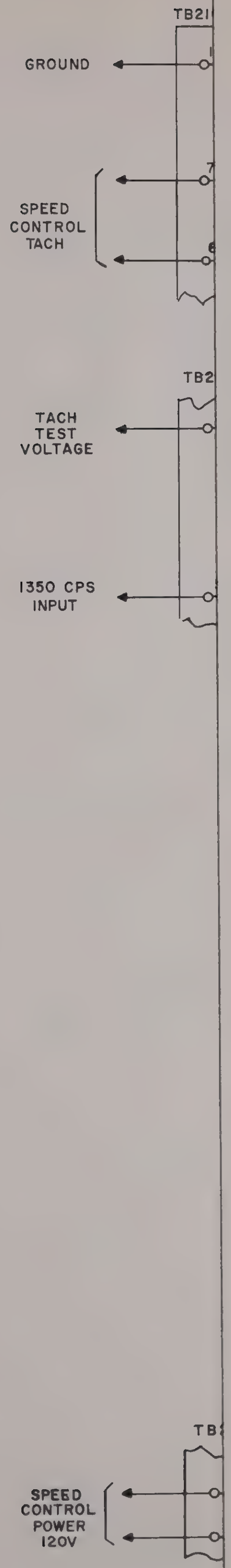
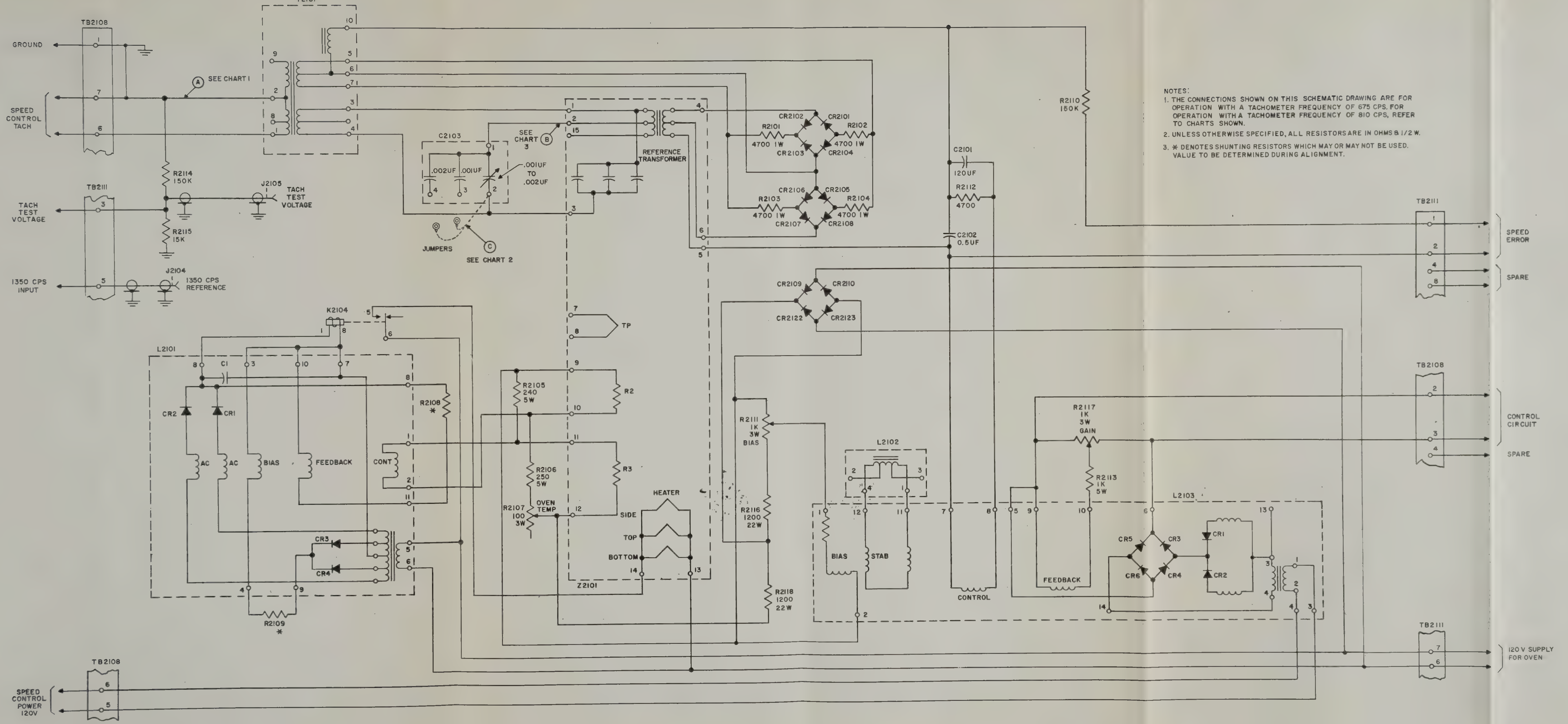


Figure 2-29. 28. Phase-Sensitive Detector Circuit, Simplified Schematic Diagram


TB21
GROUND
SPEED CONTROL TACH
TB2
TACH TEST VOLTAGE
1350 CPS INPUT
TB
SPEED CONTROL POWER 120V



NOTES:

1. THE CONNECTIONS SHOWN ON THIS SCHEMATIC DRAWING ARE FOR OPERATION WITH A TACHOMETER FREQUENCY OF 675 CPS. FOR OPERATION WITH A TACHOMETER FREQUENCY OF 810 CPS, REFER TO CHARTS SHOWN.
2. UNLESS OTHERWISE SPECIFIED, ALL RESISTORS ARE IN OHMS & 1/2 W.
3. * DENOTES SHUNTING RESISTORS WHICH MAY OR MAY NOT BE USED. VALUE TO BE DETERMINED DURING ALIGNMENT.

CHART NO.1

TACHOMETER SIGNAL READING	
TACH VOLTAGE	CONNECT (A) TO
46.5V TO 48.4V	T2101 - (8)
48.8V TO 51.2V	T2101 - (2)
51.2V TO 53.5V	T2101 - (9)

CHART NO.2

FREQUENCY TRIMING	
INCREMENTS	CONNECTIONS
.001 TO .002 MFD	(C) TO C2103 (2)
.002 TO .003 MFD	(C) TO C2103 (2) JUMP C2103 (2) TO C2103 (3)
.003 TO .004 MFD	(C) C2103 (2) JUMP C2103 (2) TO C2103 (4)
.004 TO .005 MFD	(C) TO C2103 (2) JUMP C2103 (2) TO C2103 (3) (4)

CHART NO.3

675 OR 810 CPS OPERATION	
FOR 675 CPS	CONNECT (B) TO Z2101-15
FOR 810 CPS	CONNECT (B) TO Z2101-2

Figure 2-29. 29. Shipboard or Shore Antenna Control, Speed Control Preamplifier Schematic Diagram

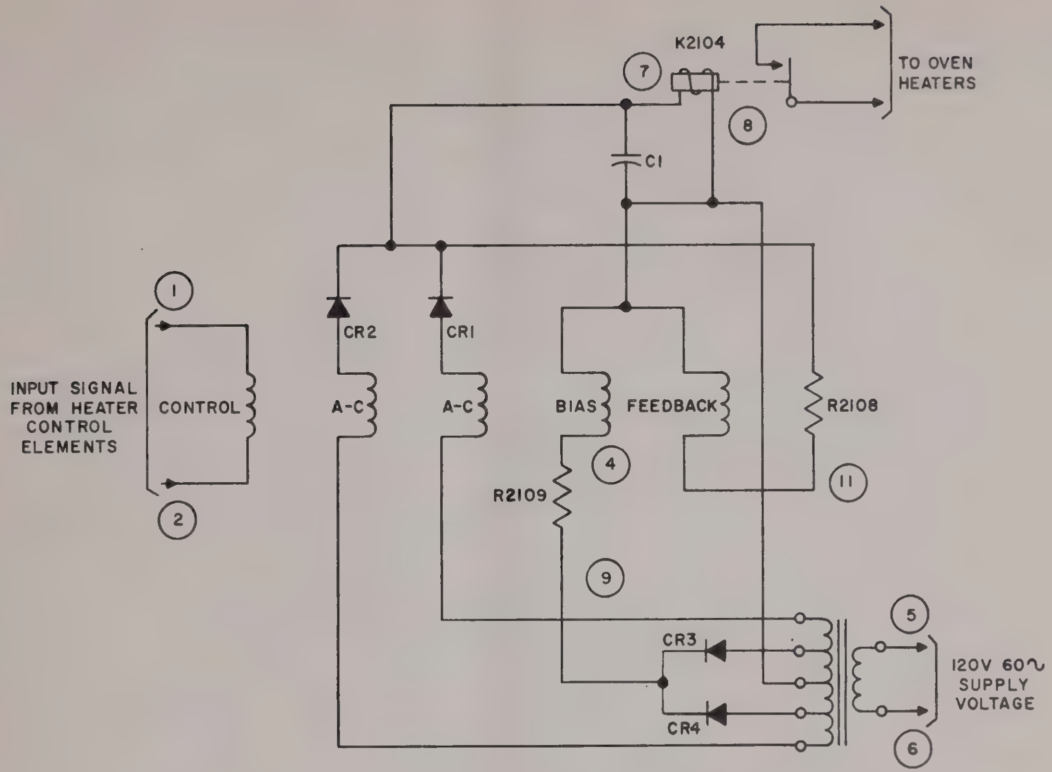


Figure 2-29. 30. Oven Control Amplifier, Simplified Schematic Diagram

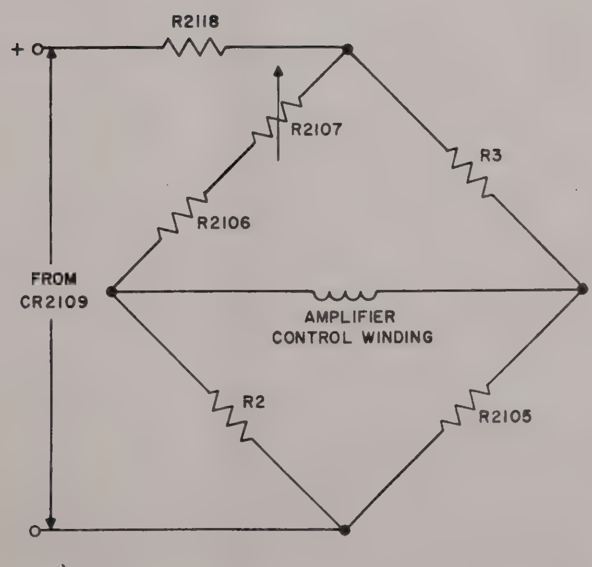


Figure 2-29. 31. Heater Elements Control Unit, Simplified Schematic Diagram

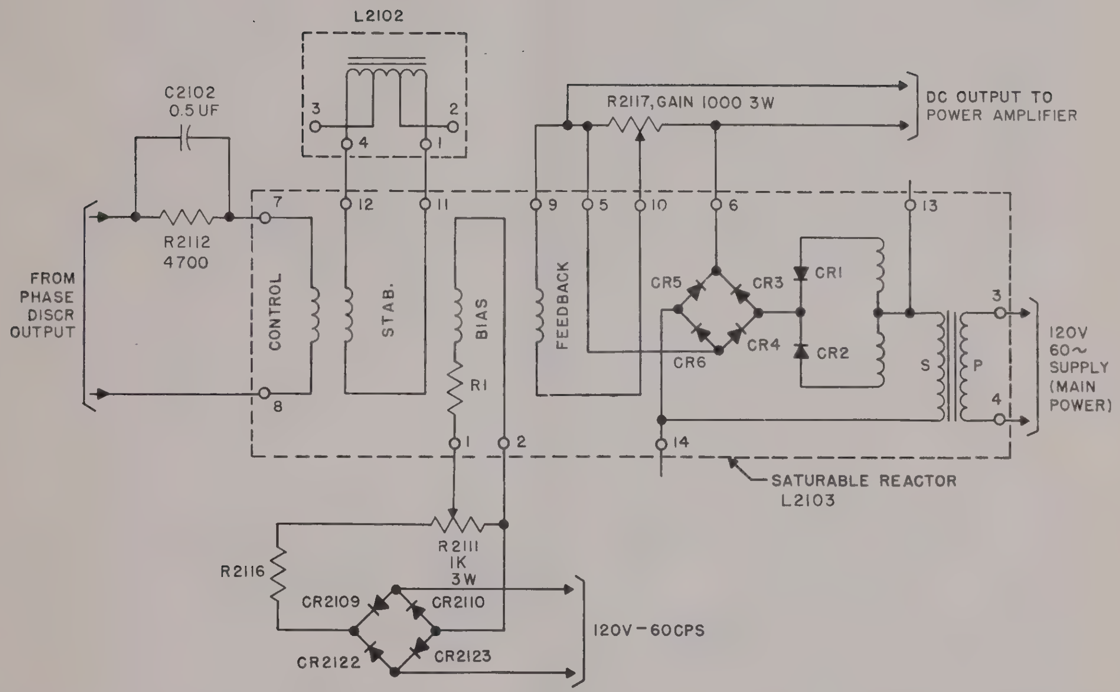


Figure 2-30. 1. Speed Control Voltage Amplifier, Schematic Diagram

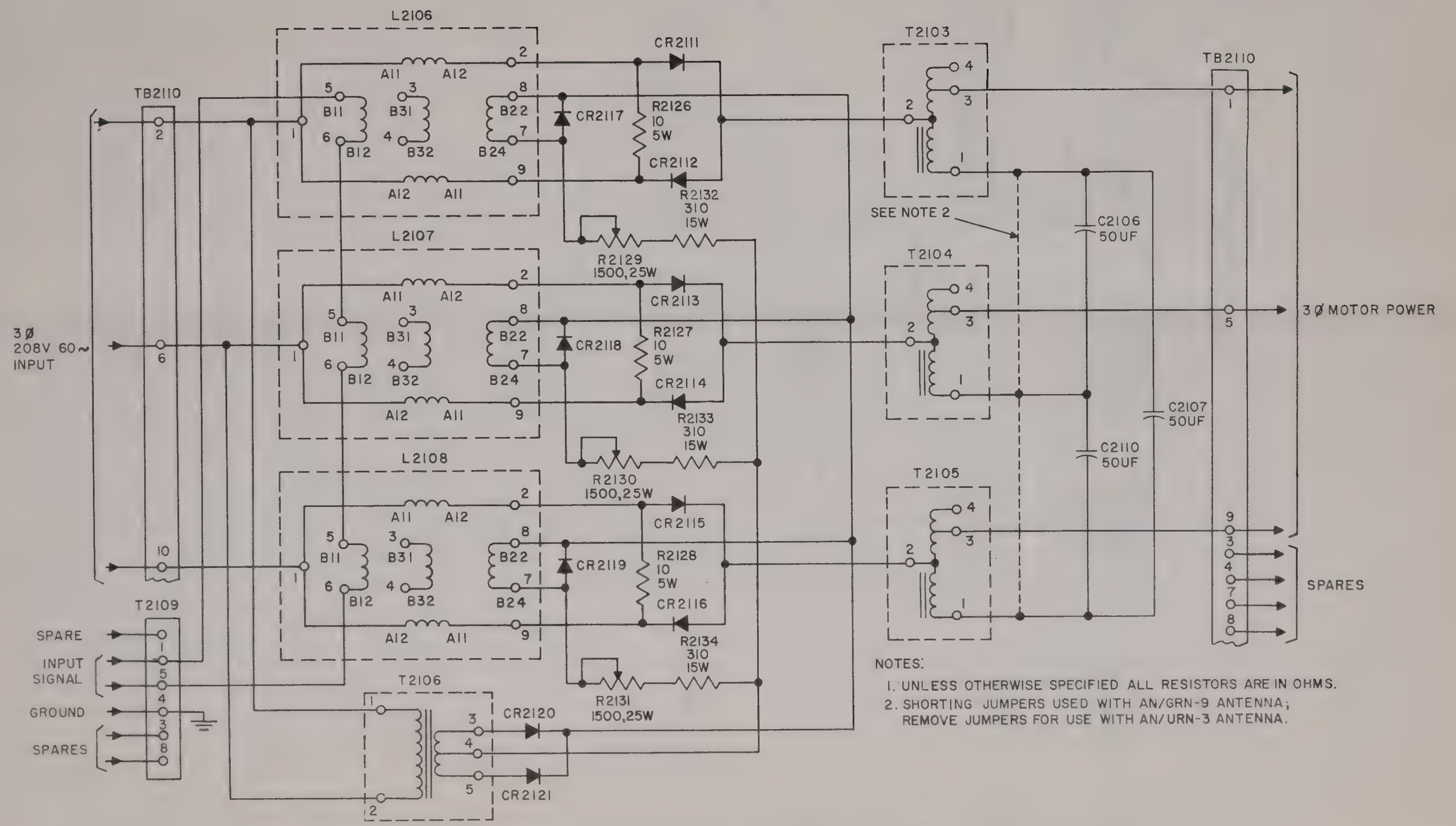


Figure 2-30. 2. Amplifier, Electronic Control AM-1720/URN, Speed Control Power Amplifier Schematic Diagram

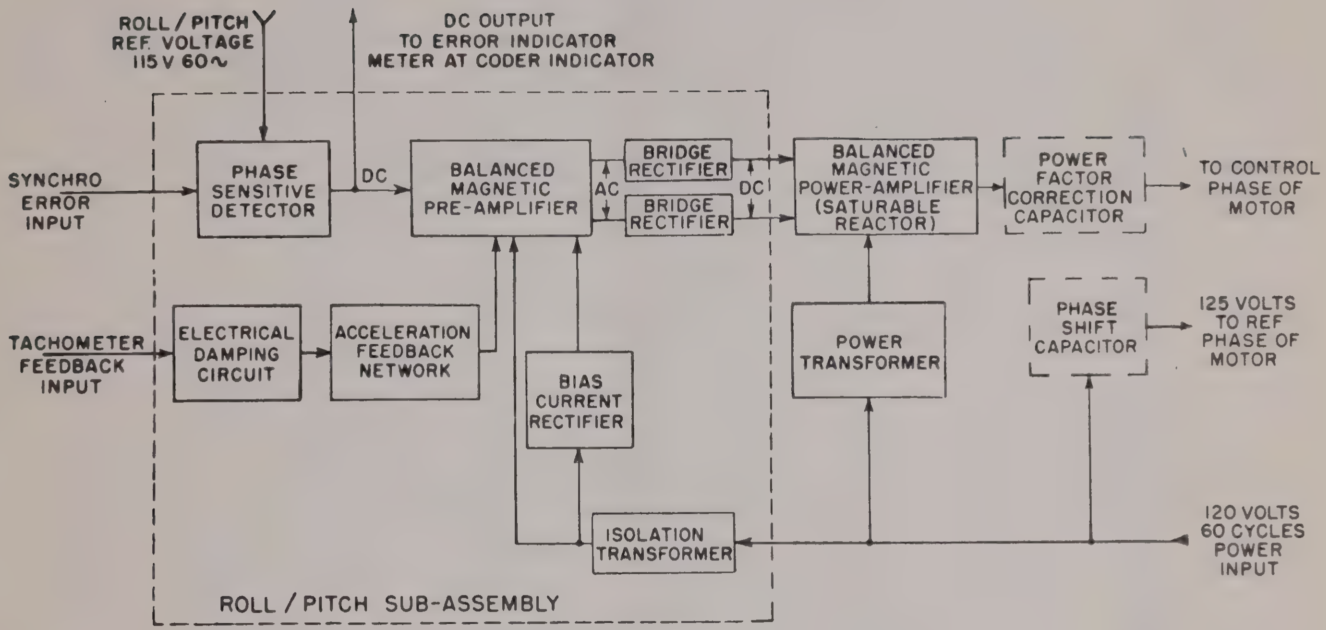


Figure 2-30.3 Antenna Group OA-1545/SRN-6, Roll or Pitch Magnetic Amplifier AR-2041 or AR-2021

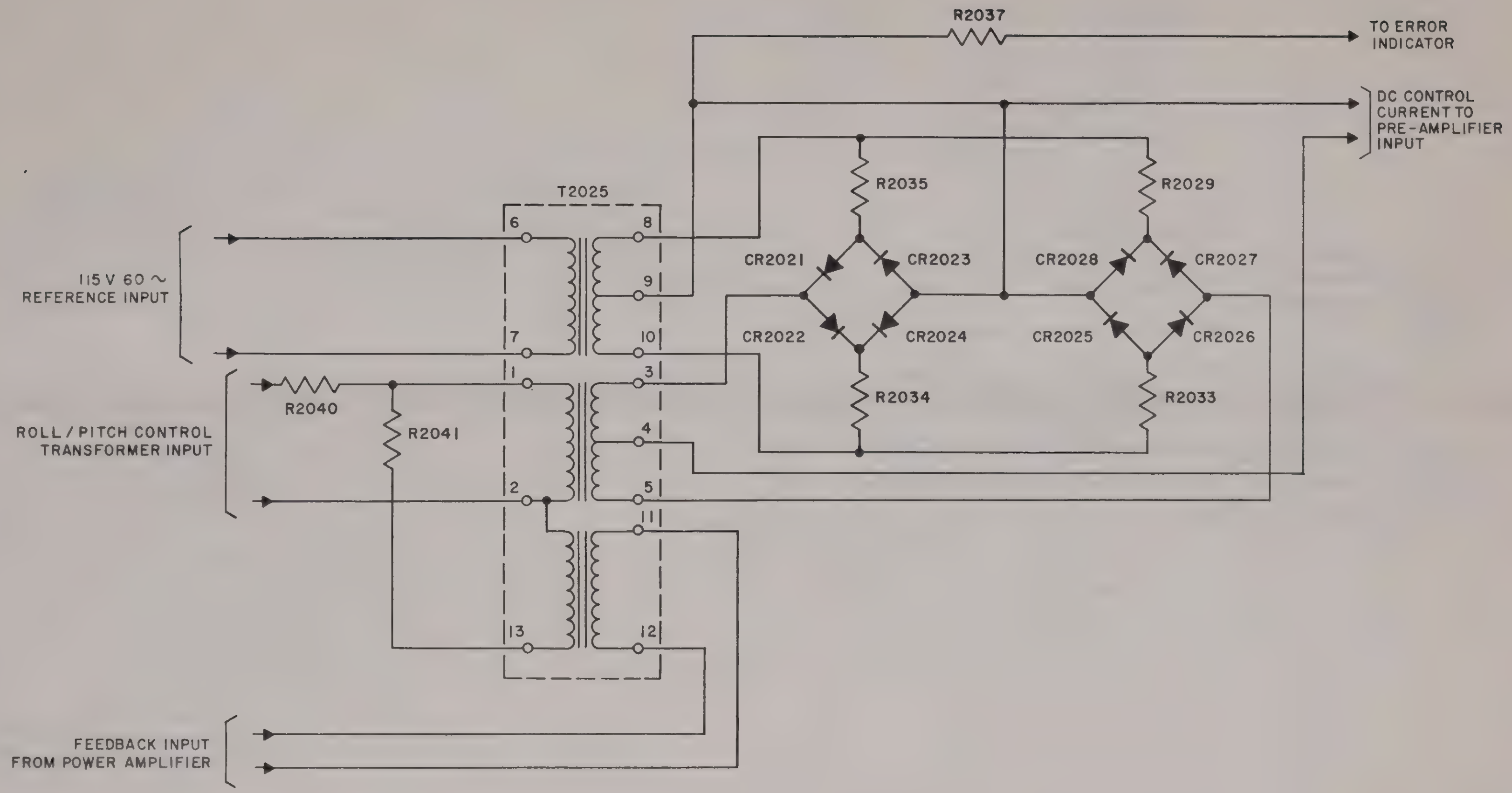


Figure 2-30. 4. Antenna Group OA-1545/SRN-6, Phase Detector Circuit, Roll or Pitch Amplifier

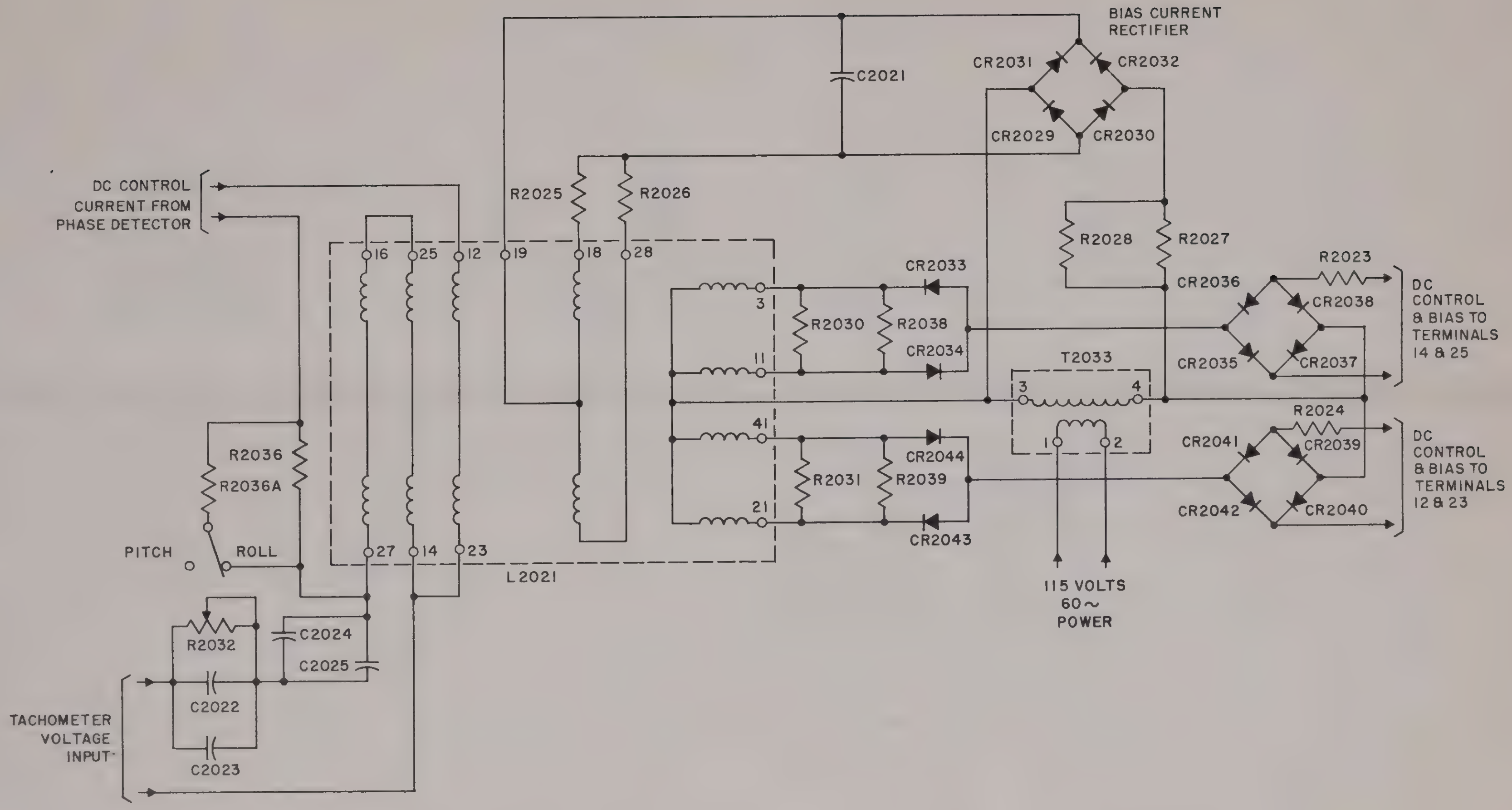


Figure 2-30. 5. Antenna Group OA-1545/SRN-6, Pitch or Roll Magnetic Amplifier, Preamplifier Schematic

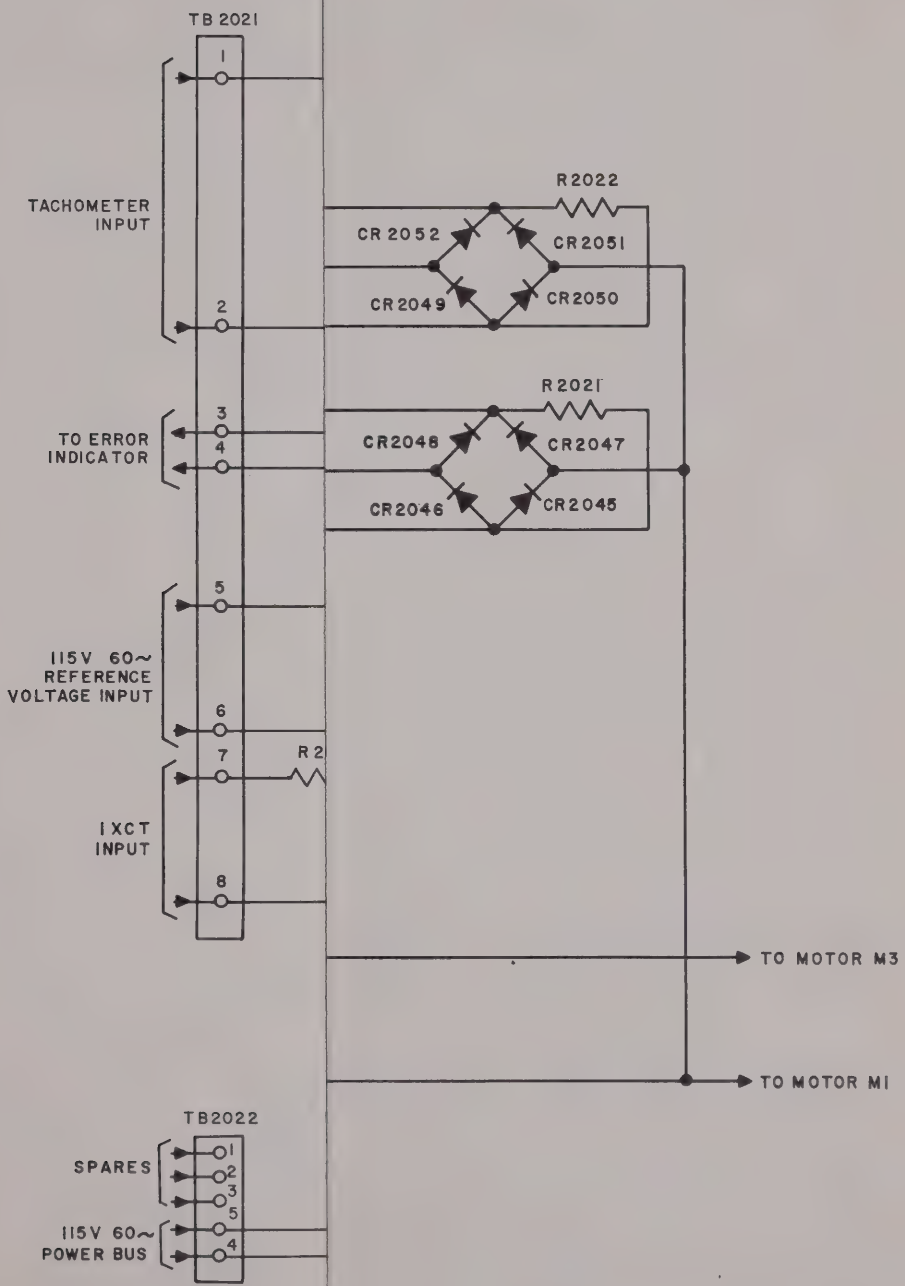


Figure 2-30. 6. Antenna Control AM-1719/SRN-6, Pitch or Roll Amplifier Schematic

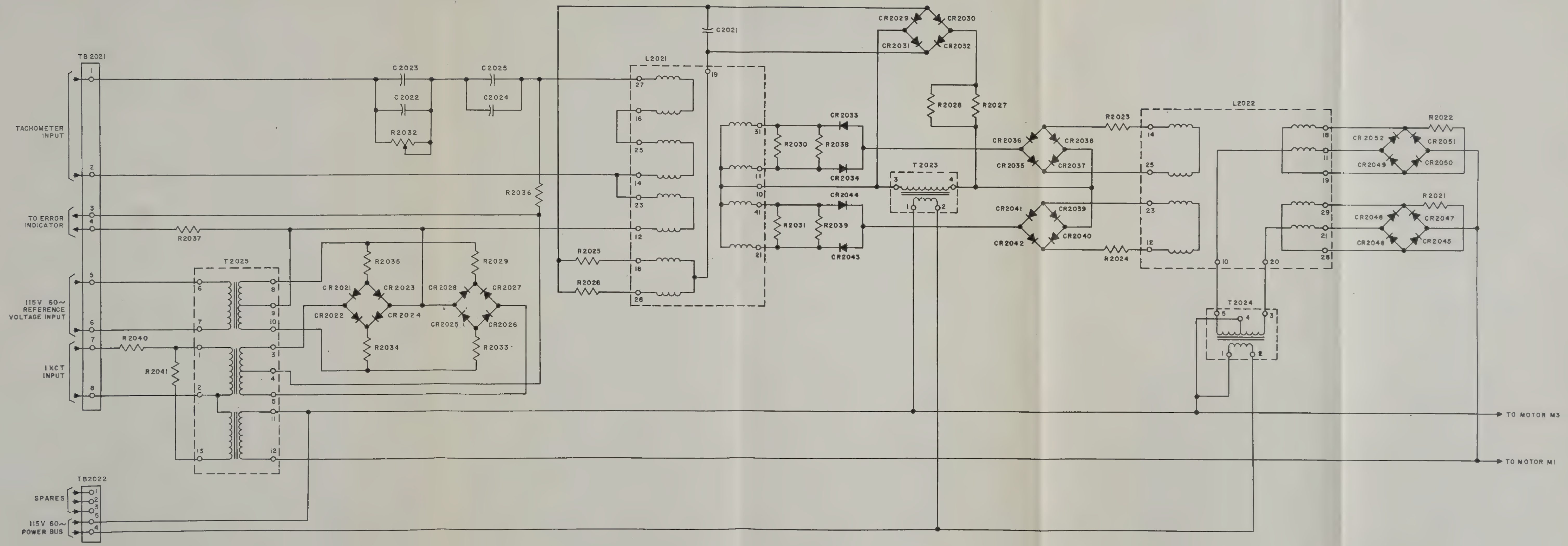


Figure 2-30.6. Antenna Control AM-1719/SRN-6, Pitch or Roll Amplifier Schematic

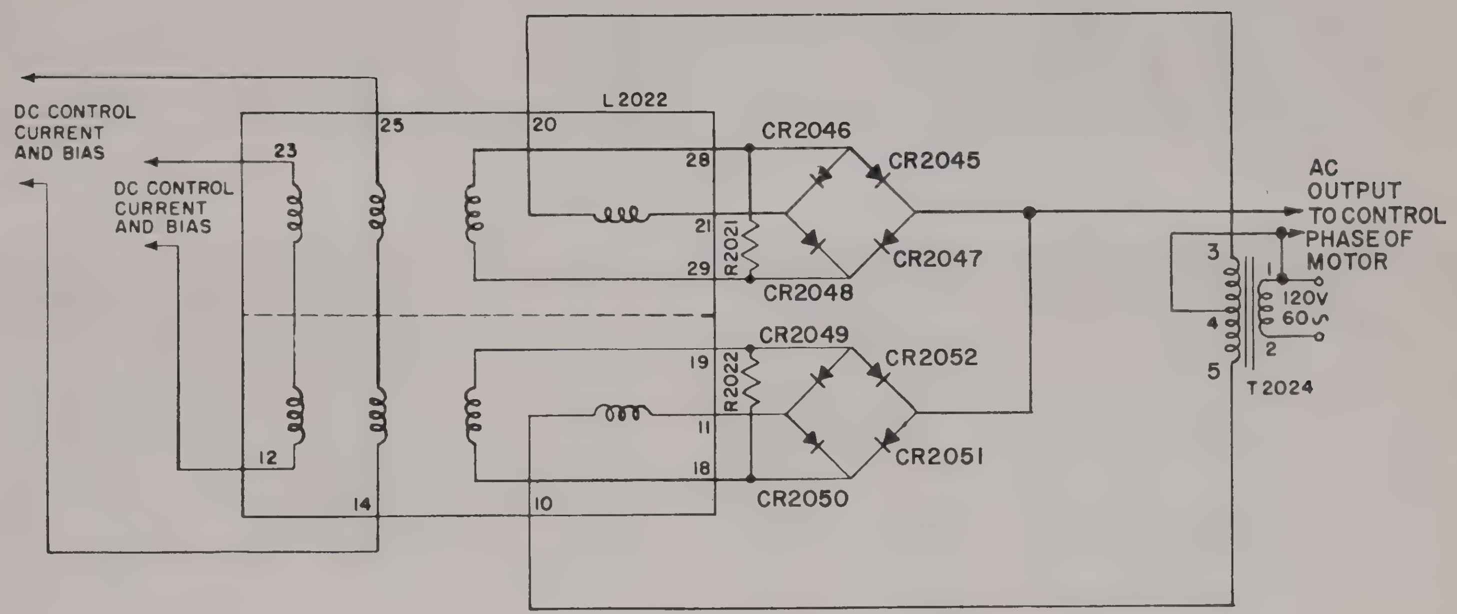


Figure 2-30.7. Amplifier, Electronic Control AM-1719/SRN-6, Pitch or Roll Power Amplifier Schematic

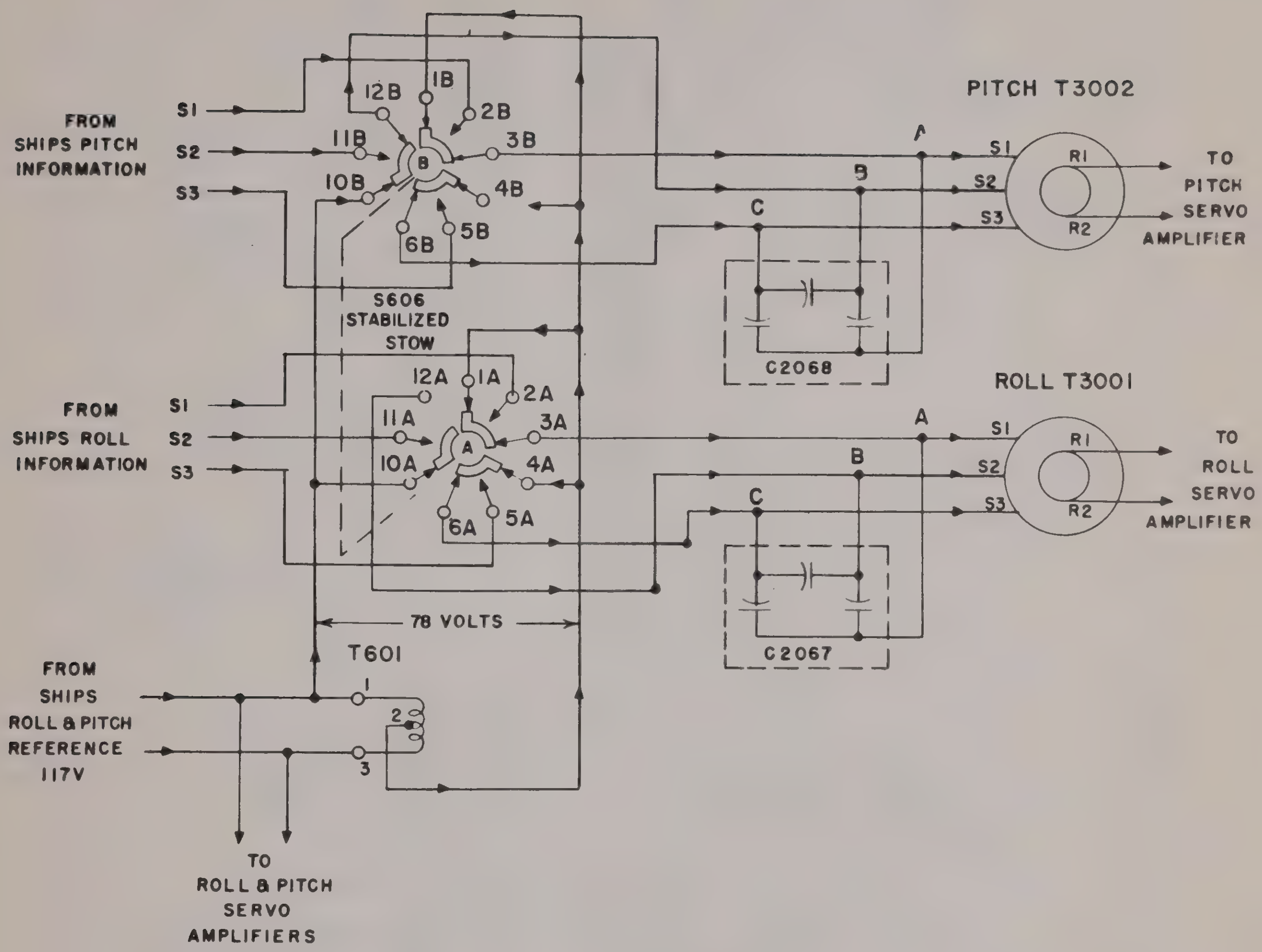


Figure 2-30.8. Antenna Group OA-1545/SRN-6, Erection Circuit Schematic Diagram

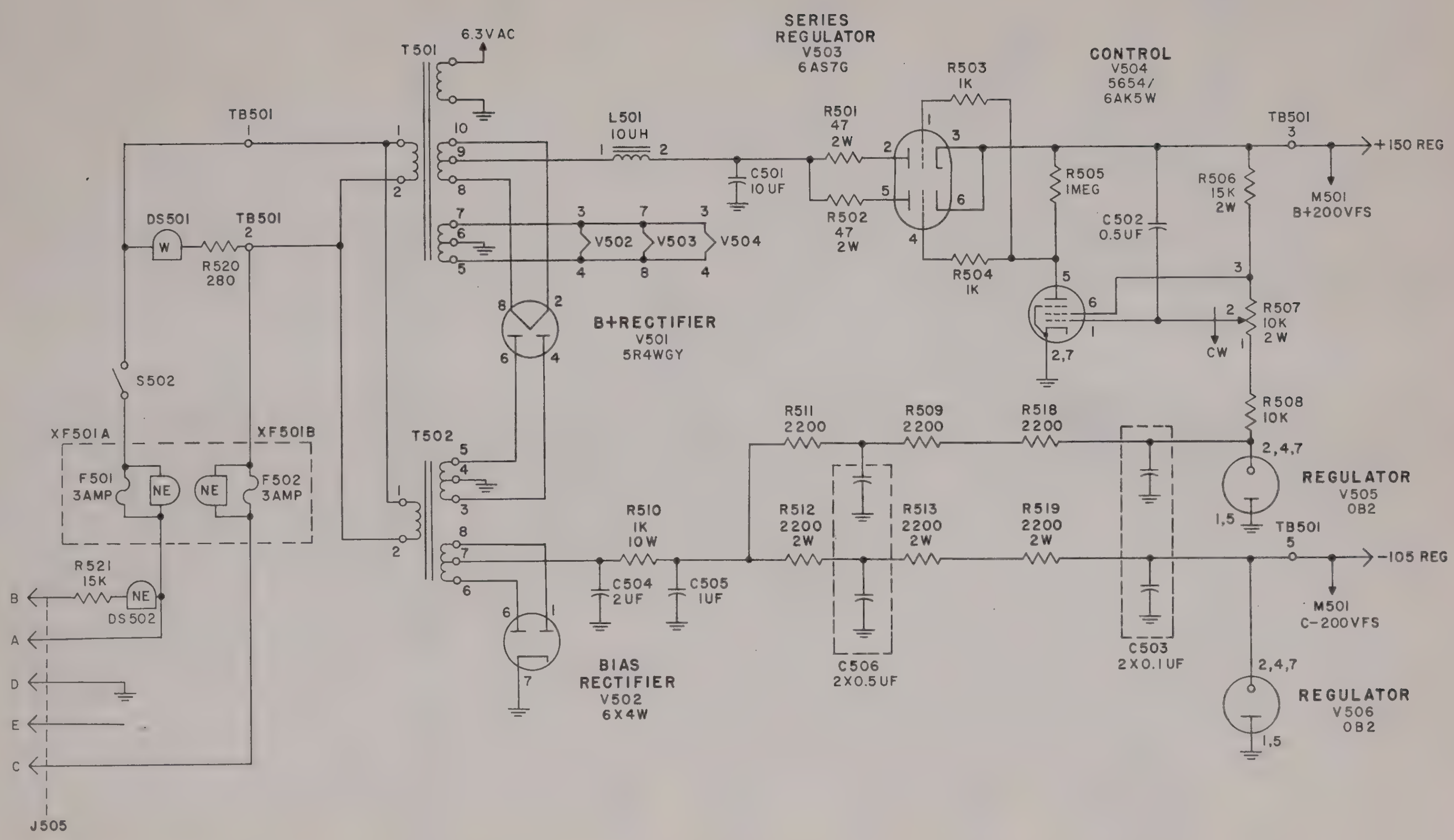


Figure 2-31. Radio Receiver R-824/URN, Power Supply, Simplified Schematic Diagram

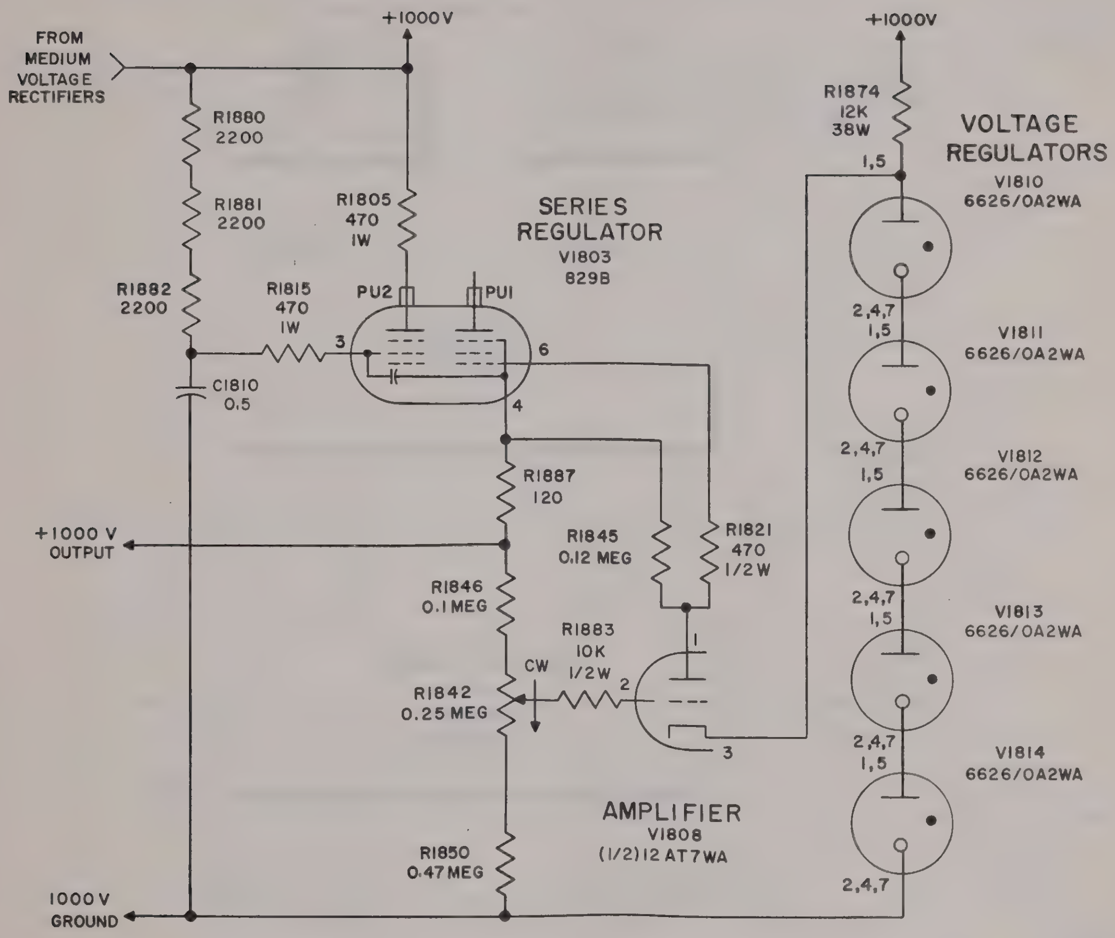


Figure 2-32. Medium Voltage Power Supply PP-1765/URN, Voltage Regulator, Simplified Schematic Diagram

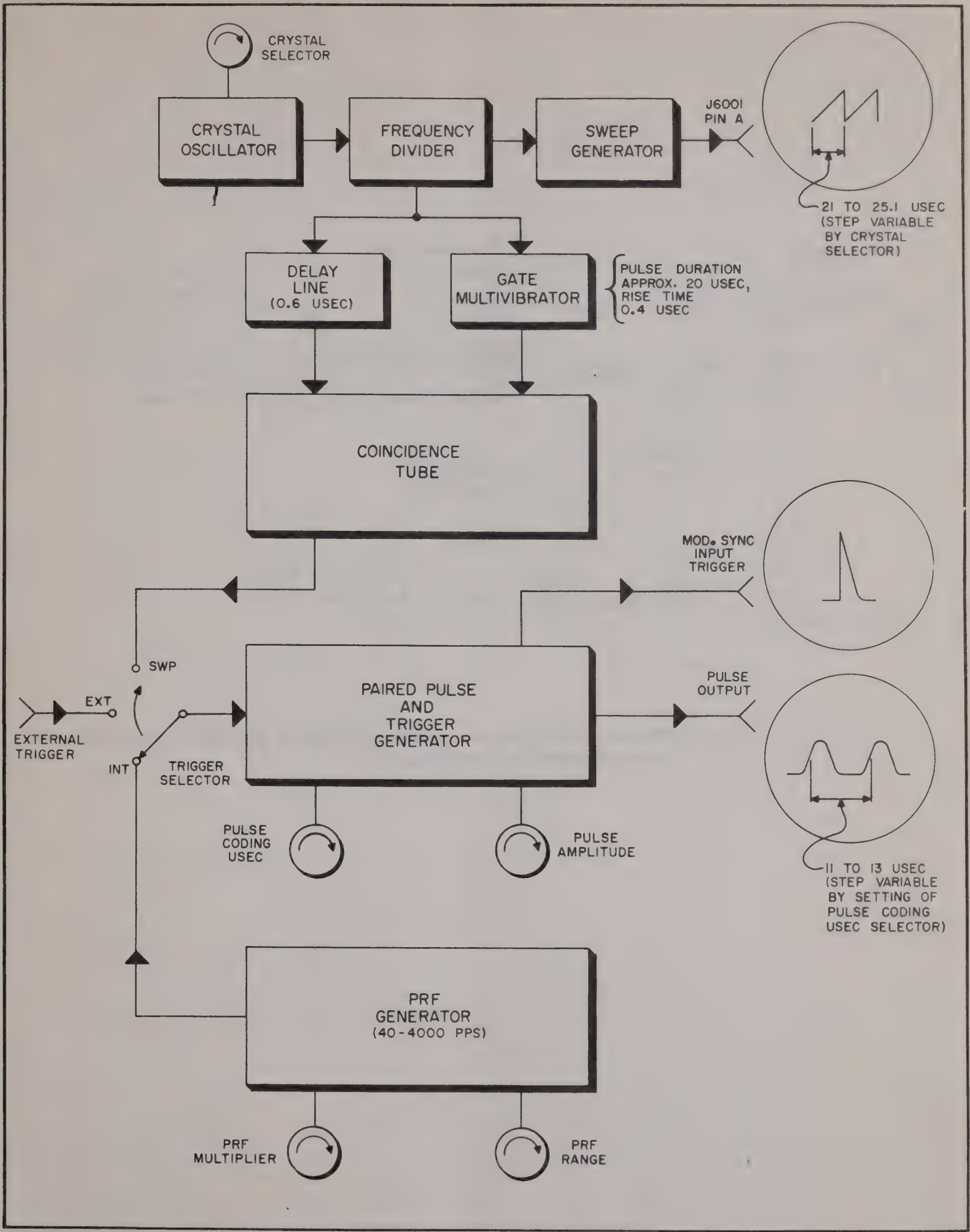
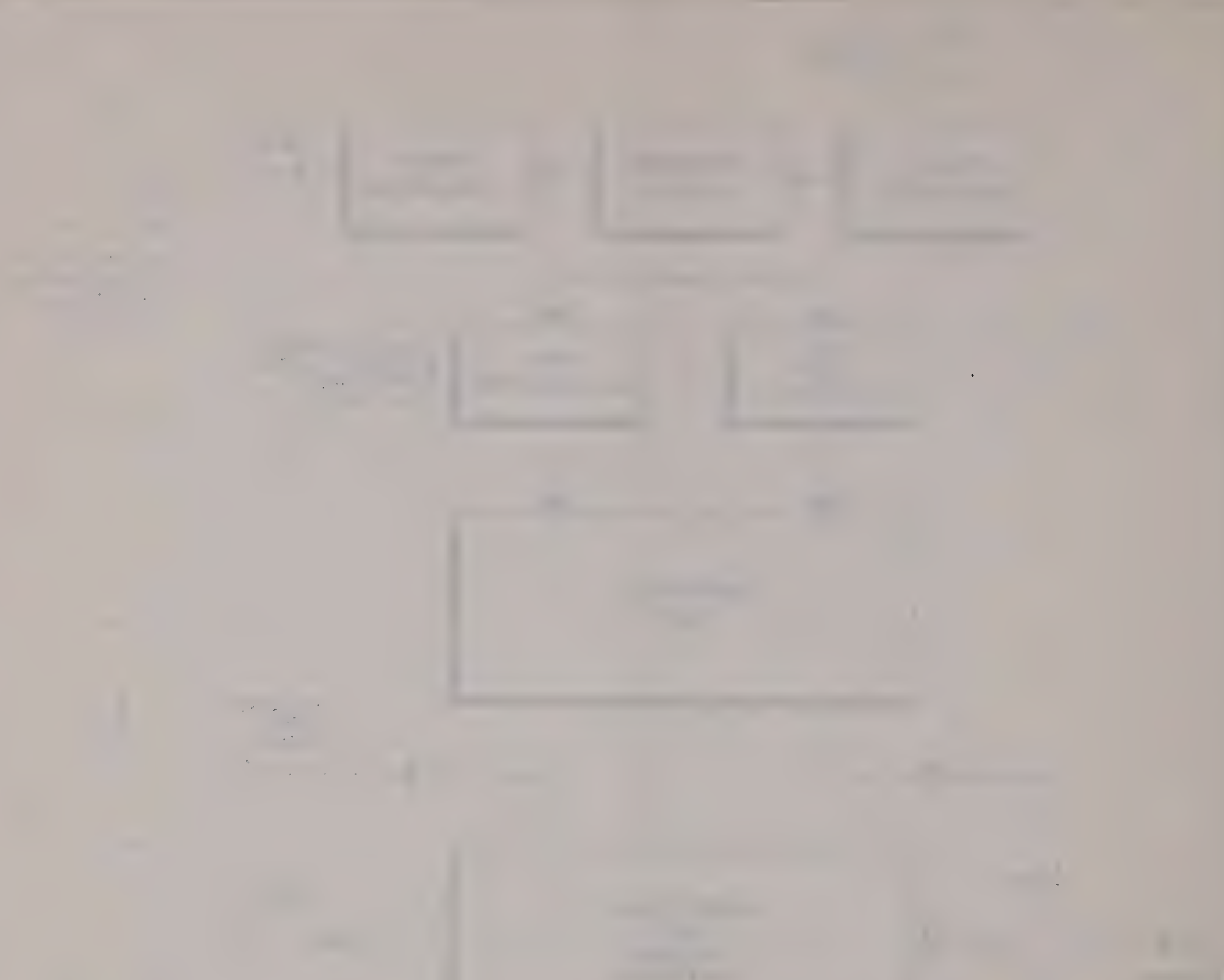


Figure 2-34. Pulse Sweep Generator SG-121A/URN-3, Simplified Functional Block Diagram



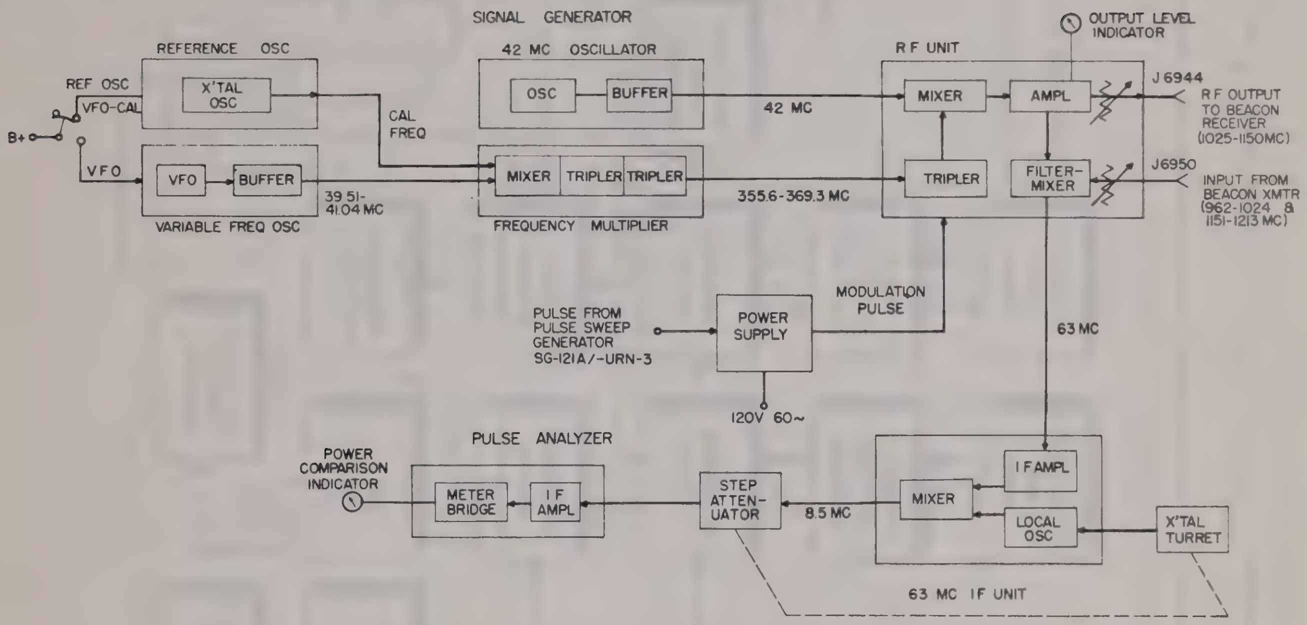


Figure 2-35. Pulse Analyzer-Signal Generator TS-890/URN-3, Simplified Functional Block Diagram

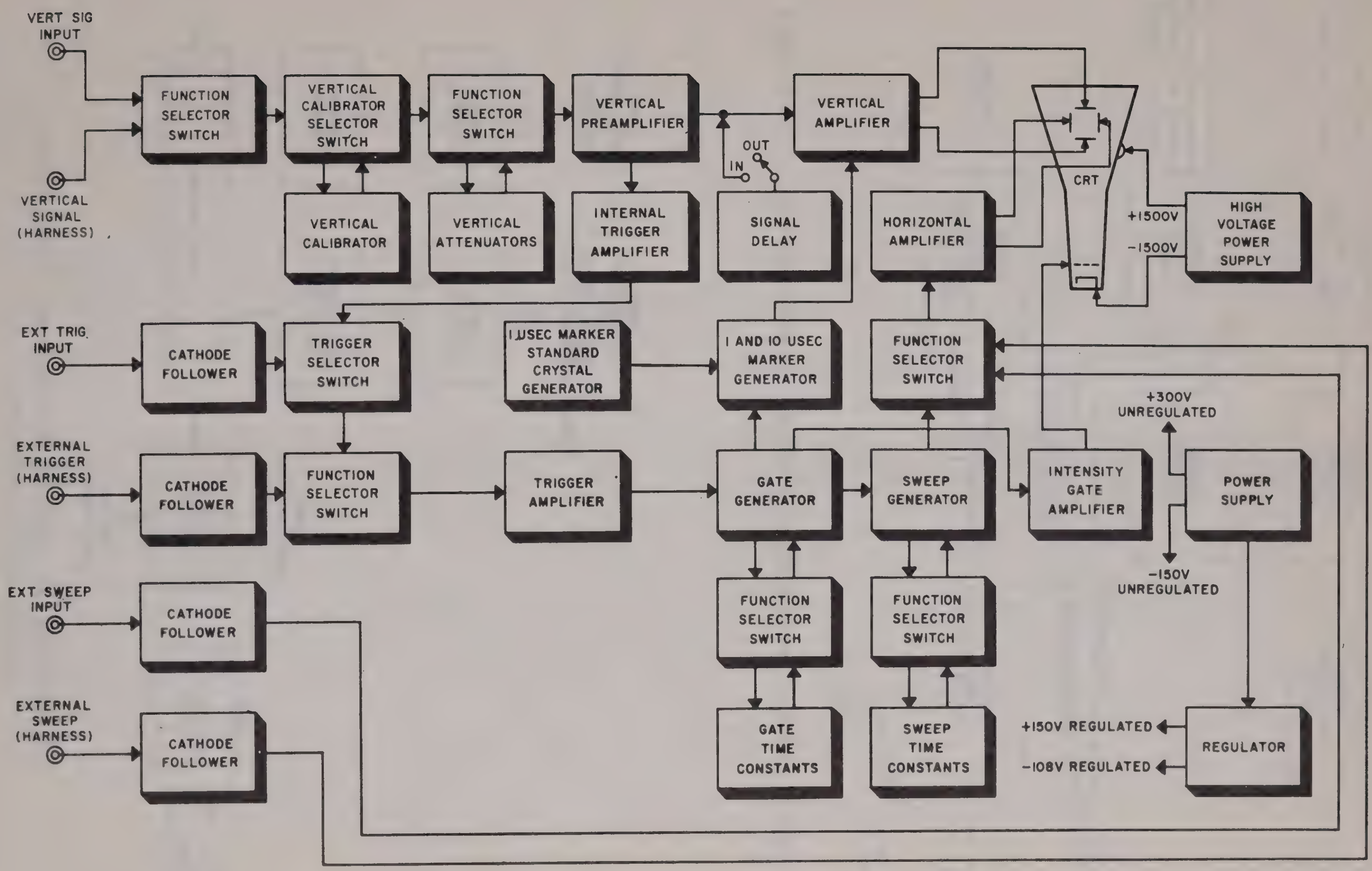


Figure 2-36. Power Meter-Pulse Counter, TS-891/URN-3, Simplified Functional Block Diagram

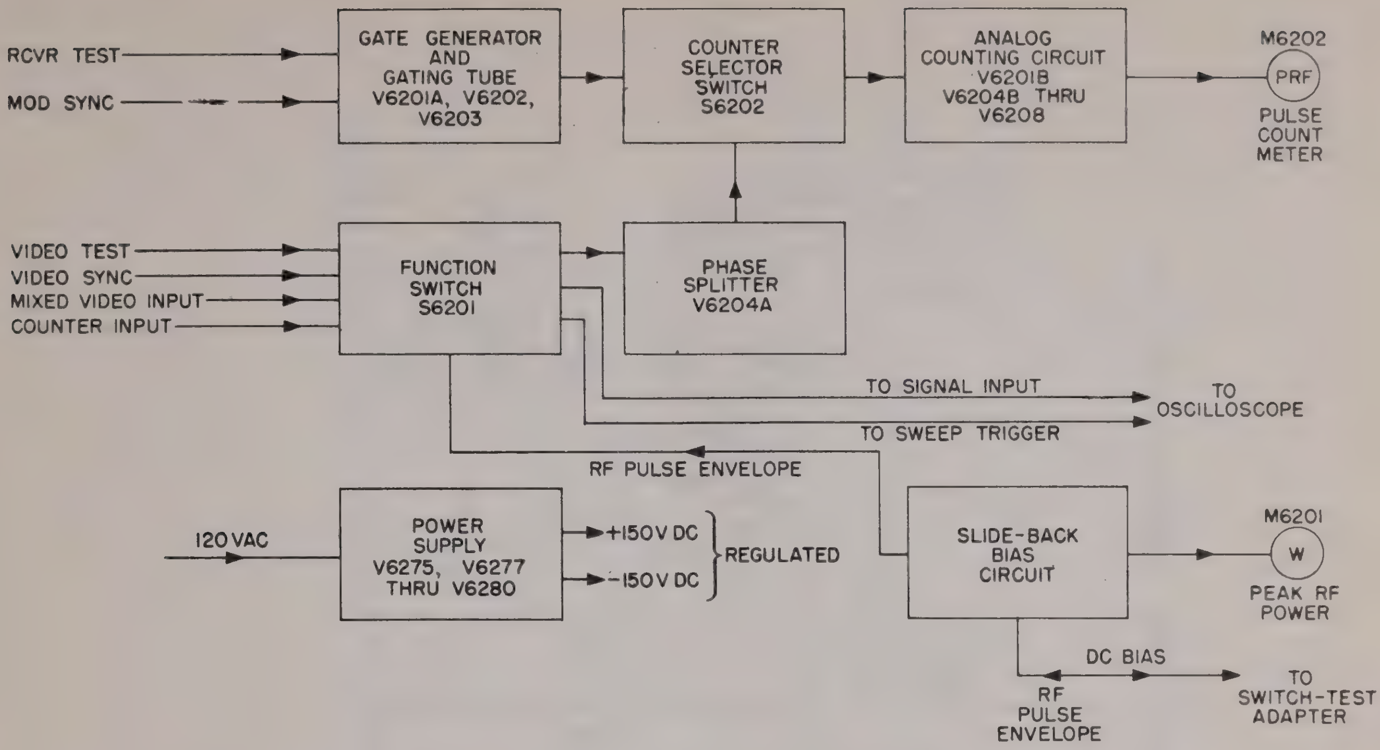


Figure 2-37. Oscilloscope OS-54/URN-3, Simplified Block Diagram

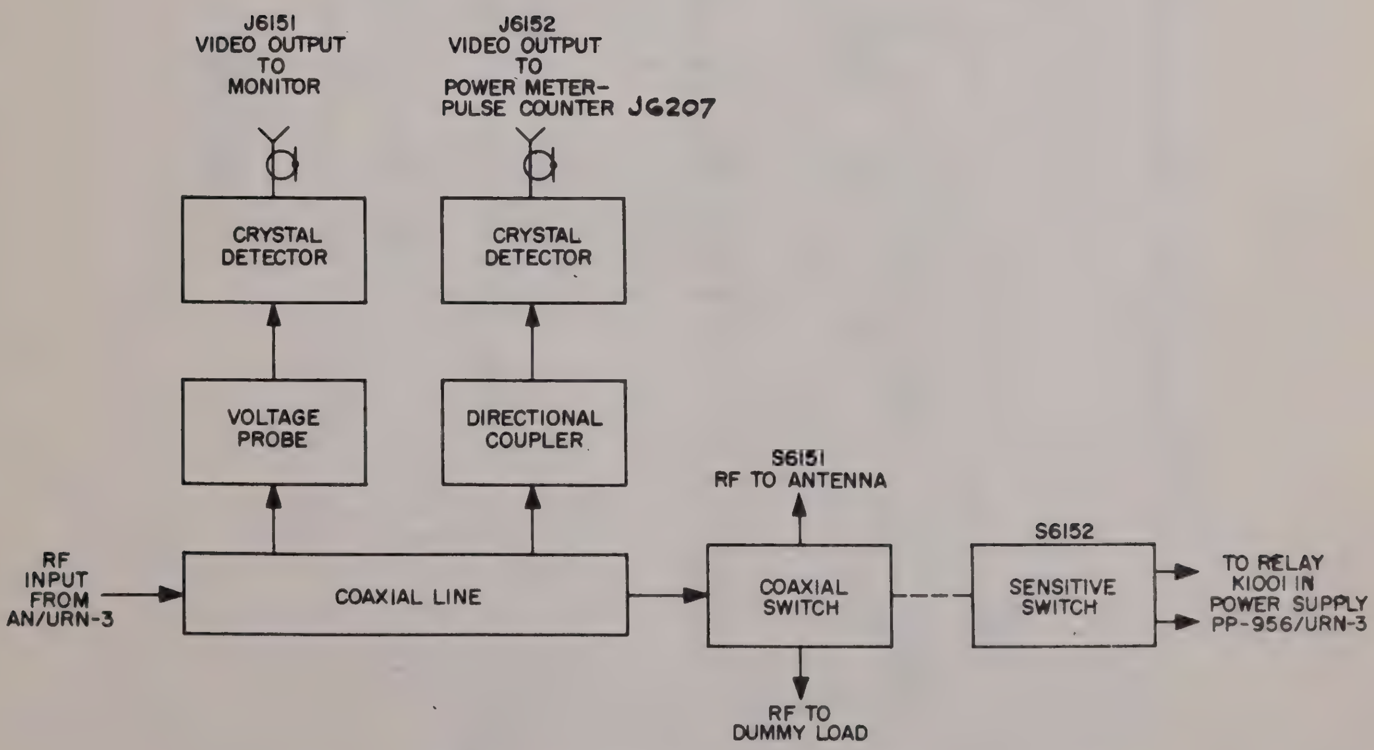


Figure 2-38. Switch-Test Adapter SA-420/URN-3, Simplified Block Diagram

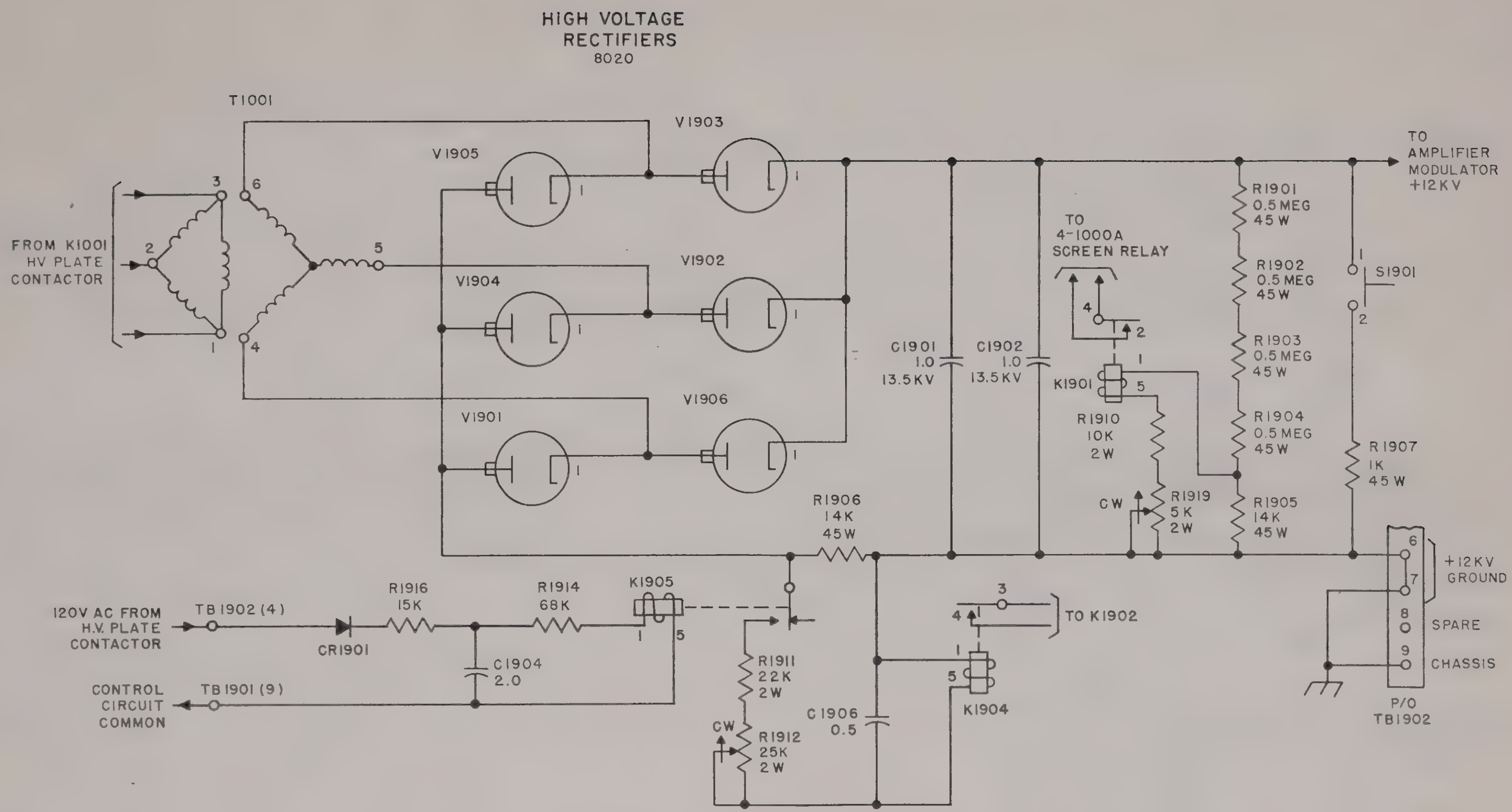


Figure 2-39. High Voltage Power Supply PP-1764/URN, Simplified Schematic Diagram

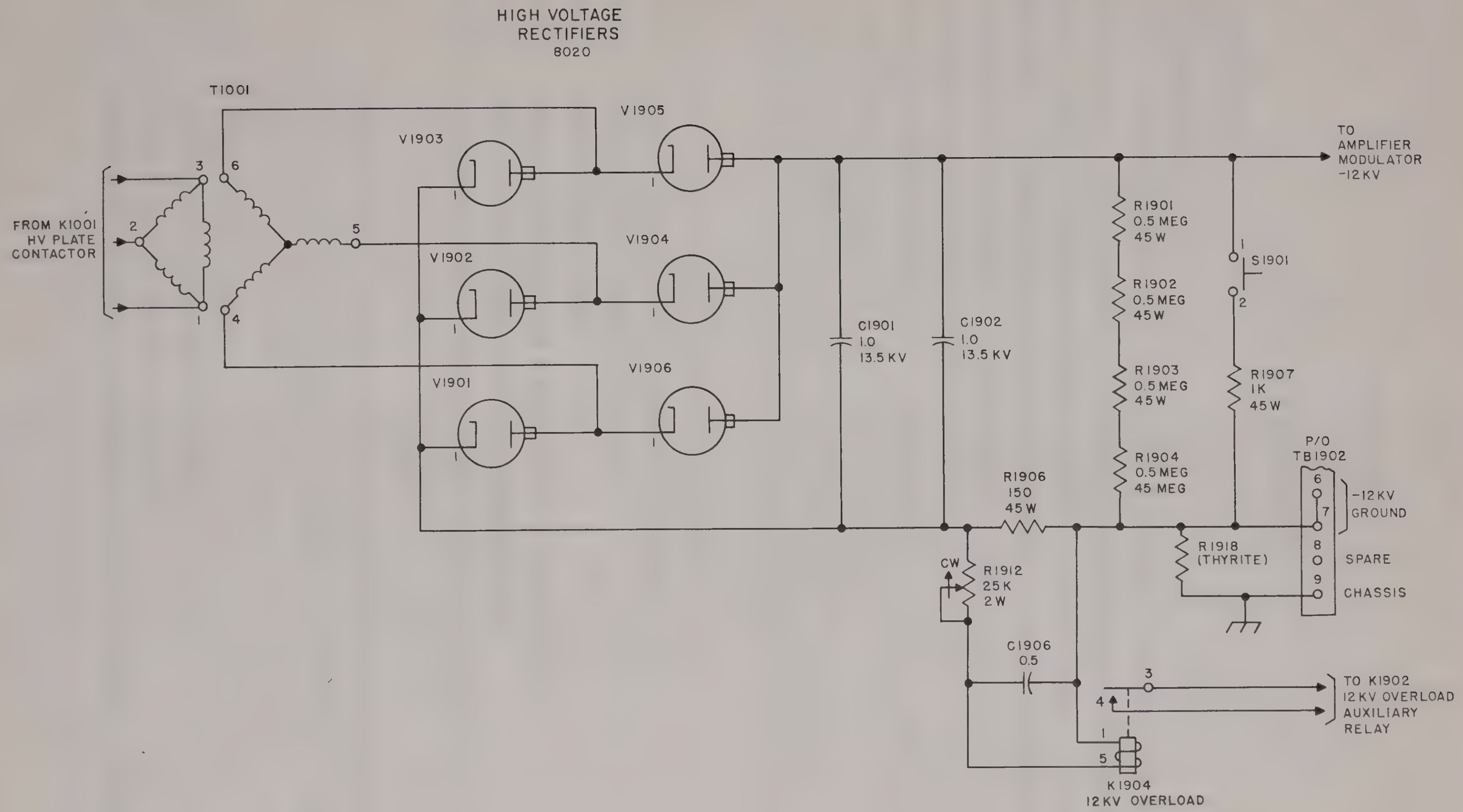


Figure 2-40. High Voltage Power Supply PP-1763/URN, Simplified Schematic Diagram

SECTION 3

INSTALLATION

1. UNPACKING.

(See figure 3-1.)

a. The components and accessories of the radio beacon are packed in several crates. For a list of crates and packages constituting the complement of a shore or shipboard radio beacon, refer to table 1-1 or 1-2, respectively. Before unpacking the equipment, determine the exact location for each major component. Then bring the crate containing the component to the immediate vicinity of the location selected for it. Unpack the equipment in an orderly manner, one component at a time, and in the order in which the major components are to be installed.

b. A typical component unpacking diagram is shown in figure 3-1. Unpack the equipment in accordance with the procedure outlined in the following steps:

Step 1. Use a nail puller to remove all nails.

Step 2. Remove outer layer waterproof paper.

Step 3. Remove inner layer of paper.

Step 4. Remove all straps.

Step 5. Remove the top and sides of the wooden crate.

Step 6. Tear off inner layer of waterproof paper.

Step 7. Check humidity indicator for presence of moisture.

Note

If the humidity indicators show that moisture has penetrated to the equipment, it must be examined carefully for signs of corrosion or fungus.

Step 8. Remove desiccant.

Step 9. Remove the corrugated pads.

Step 10. Remove the front blocking strip.

Step 11. Install two eyebolts and attach tackle to support weight.

Note

The consolidating parts box, which is included in the shipment of the radio beacon, contains two eyebolts that are used when lifting the receiver-transmitter group and the power supply-test set group. The consolidating parts box also contains electron tubes to be installed in these groups, as well as cable connectors, etc.

Step 12. Loosen the turnbuckle.

Step 13. Remove the clamp and block.

Step 14. Lift the cabinet off the platform by means of the eyebolts.

c. The receiver-transmitter group and the power supply-test set group are now uncrated and ready for installation. Follow the same procedure, omitting the steps that do not apply to uncrate the other units of the radio beacon.

2. INSTALLATION OF RADIO SET AN/GRN-9 OR AN/GRN-9A WITH ASSOCIATED ANTENNA GROUP AND ACCESSORIES (Shore Installation).

a. RECOMMENDED LOCATIONS FOR RECEIVER-TRANSMITTER GROUP AND POWER SUPPLY ASSEMBLY. - The receiver-transmitter group and power supply assembly should be placed as close together as practical (but with a minimum of 15 inches apart) and should be placed so as to be accessible for operation and maintenance. The maximum permissible distance between the cabinets is five feet. Figure 3-2 shows the placement of the components of a radio beacon for a typical installation and the dimensional data and mounting details.

b. PROCEDURE FOR DETERMINING LOCATION FOR ANTENNA PEDASTAL AND ANTENNA. - The antenna should be located on the highest available terrain and should be mounted as high as possible above level ground in order to provide maximum line-of-sight range and best performance of the system. Objects in the immediate vicinity are the ones most likely to be objectionable as far as performance of the equipment is concerned. The antenna should, therefore, be located so that its pedestal is well above all objects in the immediate vicinity, particularly within a radius of 25 feet. Objects beyond about 1, 000 feet distance will only cause shadows but will not cause substantial errors in any region except the shadow region. Very large buildings such as hangers, if they are considerably higher than the top of the antenna, may, theoretically, cause error even when beyond 1, 000 feet

distance, but such error will be localized in the region of specular reflection and will, in practice, usually not be troublesome. When located in a wooded area, it is preferable to have the antenna above the tops of the majority of trees, particularly if it is a dense growth. Trees cause an absorption of the signal which tends to decrease the range, thereby making it advisable to have the antenna above the trees in order to obtain maximum range. Occasional higher trees which extend above the antenna are permissible if not too close.

A good rule of thumb is as follows: Objects in proximity of the antenna should be under a truncated cone, the upper portion comprising the base structure of the antenna. The sides of the cone should slope downward from the antenna base at an angle of 35° below the horizon, and should extend to meet the sides of another inverted cone, the apex of which lies 12 feet directly below the antenna base, and the sides of which slope up at an angle of 3° above the horizontal (see figure 3-3). The remaining area about the antenna should be cleared of objects which protrude into this inverted cone with the exceptions noted below.

(1) One or two obstructions protruding one or two degrees above the specified 3° inverted cone are permissible if each one subtends less than 10° in bearing.

(2) Alternatively four or five obstructions protruding four or five degrees above the specified 3° inverted cone are permissible if each one subtends less than 3° in bearing.

(3) If the protruding obstructions permitted by exceptions (2) or (3) above consist of vegetation such as trees or bushes, they may protrude by twice the above specified amounts and may subtend three times the above specified angles in bearing.

(4) In general, no obstruction beyond 1, 000 feet will give objectionable reflections; however, shadowing may reduce the low altitude coverage behind such obstruction. (If the obstruction is a very large building, considerably higher than the antenna, a detailed consideration of its orientation may be advisable.) Consult the table shown in figure 3-3 for a summary of the above rules.

c. ORIENTATION OF ANTENNA RELATIVE TO NORTH-SOUTH LINE. - The orientation of the antenna base with respect to magnetic north is of

extreme importance. (See figure 3-4.) The accuracy of the system depends upon this alignment. Whatever error is incorporated in the antenna alignment appears as error in the airborne bearing indications. It is not sufficient to align the antenna with a compass since compass indications are affected by local magnetic conditions. Determination of a magnetic north-south line by a compass is only temporarily satisfactory in lieu of some other accurately determined reference line or a shot on Polaris.

The following simplified procedure is recommended for finding true north in the northern hemisphere:

(1) The lines labeled LOWER CULMINATION and UPPER CULMINATION in figure 3-5 indicate the hour at which Polaris (the north star) is precisely north. When sighted at this time no easterly or westerly correction is necessary. To find true north, therefore, sight on Polaris at the time specified in the chart. For example, on May 15 Polaris is in lower culmination at 10 p.m. Therefore, a sighting taken at 10 p.m. will require no correction.

(2) The local central time given in the chart is substantially correct for any year. To convert watch time for local central time, add to the watch time four minutes for every degree of longitude that the observation is east of the meridian from which the watch time is reckoned. Subtract if west. For example: watch 10:00 central standard time (ninetieth meridian); observation 87° west longitude. 10:00 + 3 x 4 = 10:12 (local central time). This conversion is necessary only when watch time and local central time differ substantially.

(3) The method described above is one of the simplest and most accurate methods of determining true north in the northern hemisphere. If it is inconvenient or impossible to use this method, consult the appropriate manuals of navigation or surveying for other applicable methods.

CAUTION

It must be kept in mind that the operation of this antenna is not with respect to true north, but is with respect to magnetic north. Consult Sectional Aeronautical Charts of the areas involved to obtain magnetic variation. True NORTH and SOUTH marks are built into the mounting flange of the antenna base (see figure 3-4). These marks

CAUTION (Cont'd)

must be lined up with the true north-south line in the antenna base. The NORTH mark must be on the north side of the antenna so that when an observer is on the south side of the antenna he sees the SOUTH mark when looking toward the antenna. Magnetic variation of the locality must be set into the antenna by means of the magnetic variation subassembly located in the coder-indicator unit.

In the case of mobile installations, if it is not possible to reorient the vehicle carrying the antenna so that the above described orientation can be obtained, it will be necessary to determine the angle between these marks on the antenna and the true north-south line. When this angle is determined, it may be set into the magnetic variation unit included in the coder-indicator.

For variations west of the true north-south line the coder-indicator dial should be rotated toward increasing numbers, that is, from zero up to 10°, 20°, etc. For deviations to the east, the coder-indicator dial should read from zero down, that is, zero toward 350°, 340°, 330°, etc.

d. AMPLIFIER, ELECTRONIC CONTROL AM-1720/URN (ANTENNA CONTROL UNIT). - The antenna control unit should be located where it will receive protection from the weather, and where it will be accessible for inspection and maintenance. See figure 3-6. The cable connecting it to the antenna and the receiver-transmitter group must not exceed 150 feet and 100 feet respectively.

3. INSTALLATION OF RADIO SET AN/SRN-6 WITH ANTENNA GROUP AND ACCESSORIES (SHIPBOARD INSTALLATION).

a. RECOMMENDED LOCATIONS OF MAJOR COMPONENTS.

(1) RECEIVER-TRANSMITTER GROUP OA-1532/SRN-6 AND POWER SUPPLY ASSEMBLY OA-1535/SRN-6. - The Receiver-Transmitter Group

OA-1532/SRN-6 and Power Supply Assembly OA-1535/SRN-6 are placed according to the same requirements as described in paragraph 2a above for shore installations. An added requirement is that the location of these cabinets in a particular part of a ship should be made with consideration of the location of the antenna control as cables to the antenna control must not exceed 100 feet.

(2) ANTENNA, ANTENNA PEDESTAL, AND RADOME. - The antenna should be placed as high as possible, and must be above objects in the immediate vicinity. Objects within a few feet (15 feet or less) should not be above the lower edge of the pedestal for optimum performance of the radio beacon. It is preferable that more distant objects be below this line, but it is not imperative. If it is not possible to put the antenna in such a location that no objects extend above it, usable but impaired performance will be obtained. If the objects which extend above the antenna are whip antennas or similar thin metal objects, they should be at a minimum distance of 50 feet. Large objects, such as tripod masts, gun mounts, etc., should be proportionately more distant.

(3) AMPLIFIER, ELECTRONIC CONTROL AM-1719/SRN-6 (Antenna Control deck box). - The antenna control deck box is a spray-tight unit which may be located above deck, and between the antenna and the receiver-transmitter group so that the cable runs will not exceed 150 feet to the antenna and 100 feet to the receiver-transmitter group.

(4) AMPLIFIER, ELECTRONIC CONTROL AM-1718/SRN-6 (Antenna Control Unit). - The antenna control unit should be located where it will receive protection from the weather and where it will be accessible for inspection and maintenance. The cable connecting it to the antenna and receiver-transmitter group must not exceed 150 feet and 100 feet, respectively.

b. MOUNTING THE EQUIPMENT.

(1) RECEIVER-TRANSMITTER GROUP OA-1532/SRN-6 AND POWER SUPPLY ASSEMBLY OA-1535/SRN-6.

Install the receiver-transmitter and power supply-test set groups in accordance with figure 3-2. Be sure to allow sufficient clearance so that the units will be accessible for servicing when pulled out to their fully extended position.

(2) ANTENNA, ANTENNA PEDESTAL, AND RADOME.

(a) Outline and mounting dimensions for the antenna, antenna pedestal and radome are given in figure 3-7, which also provides a suggested method of mounting. The bottom plate shown in the illustration is not supplied with the equipment but must be fabricated by the installing activity. Suitable entrance for the cables must be provided in the platform on which the antenna base is mounted.

(b) Arrows marked "N" and "S" have been placed on the antenna pedestal. These arrows should be lined up with a line marked on the mounting platform that is parallel to the centerline of the ship, the "N" arrow facing forward (toward the bow of the ship) and the "S" arrow facing aft within an accuracy of 0.1°.

CAUTION

It is essential for the accurate functioning of the radio beacon to have the antenna pedestal carefully lined with the fore and aft direction of the ship.

(c) The antenna and antenna pedestal (without the radome) should be mounted on the mast as an assembled unit.

(d) The antenna and synchros, tachometers, and other small electrical apparatus of the antenna pedestal are relatively delicate with respect to the supporting framework. Care should be taken when hoisting the antenna that the hoisting gear does not come in contact with these delicate electromechanical parts. The antenna and antenna base may be tilted and hoisted in any position.

(e) After the antenna pedestal has been bolted in place, remove the roll and pitch locking pins (figure 3-7). The purpose of these pins is to hold the antenna and antenna pedestal rigidly together during installation and thus prevent damage to the roll and pitch sector gears.

Note

Before proceeding to step (f) make the electrical connections described in paragraph 5 c.

(f) Hoist the radome into place and bolt it to the platform.

(g) Seal the radome and access covers with suitable weatherproofing compound.

(3) AMPLIFIER, ELECTRONIC CONTROL AM-1719/SRN-6 (Antenna Control Deck Box). - Mount the antenna control unit either horizontally or

vertically against the bulkhead utilizing the mounting holes provided in the channels welded to the back of the unit. (See figure 3-8.) Cables may enter at the bottom or sides through the detachable cable entrance plates.

4. CABLE FABRICATION.

For the multiconductor cables shown in figures 3-9 and 3-10 a terminal lug-type connection is satisfactory. This applies to all cables shown except those with RG-18A/U, RG-118/U, and RG-10/U designations.

a. REMOVING THE ARMOR. - The method for removing the armor is as follows:

Step 1. Form the cable as it is to be run into the stuffing tube and carefully estimate where the cable should come through the tube. Mark this position with a piece of friction tape.

Step 2. Cut the armor with either a diagonal cutter or with an armor stripper. If using a diagonal cutter, be careful not to cut through the insulation.

Step 3. The cut may be taken either in front of the tape marker or within it. By cutting just in front of the marker, the cut can be closely watched. The frayed edges of the armor can then be trimmed away. When cutting within the tape marker, the tape serves to hold the frayed edges down, but care must be used to avoid cutting the insulation.

Step 4. The armor is cut around the circumference of the cable.

Note

When the length of armor to be removed is not too great, it may be worked off without further cutting, for easy removal. The important thing to remember in cutting the armor is to avoid cutting the insulation, since this may let the frayed armor edges penetrate the cable and cause grounding.

b. STRIPPING THE INSULATION. - After the armor has been removed, start to remove the insulation at a distance of approximately 1/2 inch from where the armor terminates. The following procedure is recommended in stripping the insulation:

Step 1. Place one end of the cable in a vise or have another man hold the cable.

Step 2. Put a bend in the cable and carefully ring the insulation, taking care to cut only the insulating jacket and not into the insulation of individual conductors.

Step 3. With the knife blade at an angle, start cutting a strip lengthwise, approximately 1/2 inch wide and long enough to allow side cutters to get a grip on the insulation.

Step 4. Pull down on the cut with the side cutters. This will form a 1/2-inch strip. After stripping approximately four inches, the remainder of the strip can usually be removed by hand.

c. APPLYING TERMINAL LUGS. - Remove just enough insulation so that the stripped conductor will fit the lug exactly. Always use a lug large enough to fit over all strands of the conductor. All lugs used must be soldered. However, solderless-type lugs may also be used to provide a good mechanical and electrical connection by crimping before soldering. (See figure 3-11.)

Note

> The cables used in this installation have a waterproofing compound (silicone grease) which fills all voids even in individual conductors. This grease makes the soldering of terminal lugs very difficult. Individual strands must be cleaned with Decalene (deca-hydro-napthalene).

A solder lug type 20-14 (SNSN G17-L-14325), or equivalent, if used, is connected to the cable conductors as follows:

Step 1. Slip the lug over the inner conductor and heat with a soldering iron.

Step 2. As the lug becomes warm, it can be forced under the insulation so that when it cools off it will have the added support of the insulation. (See figure 3-11b.)

Step 3. Make sure that the inner conductor is well bonded and secured to the solder lug.

d. ASSEMBLY OF THE RG-27/U CABLE, CONNECTED BETWEEN THE RECEIVER-TRANSMITTER GROUP AND THE POWER SUPPLY ASSEMBLY.

(1) Cable RG-27/U is connected betwen the receiver-transmitter group and power supply assembly for both shipboard (figure 3-10) and shore (figure 3-9) installations. This cable has a standard lug-type termination which is fastened by a nut to the special standoff insulator binding posts, E903 and E1001. The armor should be removed from each end for a length of six inches before inserting the cable in the stuffing tubes.

(2) The shielding at each end of the cable should be grounded. The two layers of shielding should be soldered together and then connected to the ground terminals on TB1004 in the power supply-test assembly entrance box and on TB903 in the receiver-transmitter cable entrance box.

CAUTION

It is extremely important that the thin layer of conducting rubber over the inner insulation be removed back at least four inches; otherwise the high voltage will cause a breakdown. If the INNER INSULATION IS CUT EVEN SLIGHTLY during preparation, the high voltage will eventually cause breakdown.

e. ASSEMBLY OF CABLE CONNECTED BETWEEN THE RECEIVER-TRANSMITTER GROUP AND THE ANTENNA PEDESTAL.

(1) For shore installations, cable RG-18/U is connected between the antenna and the receiver-transmitter group (figure 3-9). An r-f cable connector, Navy type UG-154A/U, connects one end of this cable through adapter UG-216B/U to the receiver-transmitter group jack J1155. A type UG-1041-A/U plug connects the other end of this cable to antenna jack J3302, a type 427B/U. Figure 3-12 provides complete assembling instructions for this type connector.

(2) For shipboard installations, cable RG-118/U is connected between the antenna and the receiver-transmitter group (figure 3-10). An r-f cable connector, Navy type UG-154A/U, connects one end of this cable through adapter UG-216B/U to the receiver-transmitter group jack, J1155. A type UG-926A/U plug connects the other end of this cable to antenna jack J3002. Figure 3-12 provides complete assembling instructions for this type connector.

Note

Before mating type connector UG-154A/U into the adapter, coat face of dielectric with dielectric compound ANA Spec AN-D-128.

f. ASSEMBLY OF THE RG-10/U CABLES, CONNECTED BETWEEN THE RECEIVER-TRANSMITTER GROUP AND 15-CPS AND 135-CPS PICKUP COILS IN THE ANTENNA PEDESTAL. - Cable RG-10/U is connected between the antenna and the receiver-transmitter groups for both shipboard (figure 3-10) and shore (figure 3-9) installations. The r-f cable connectors, Navy

type UG-943A/U, for the 135-cps and 15-cps reference pulse cables, connect both ends of these cables to the equipment. Figure 3-13 provides complete assembling instructions for this type connector.

5. LAYOUT AND INSTALLATION OF CABLES.

a. GENERAL. - After all cables have been fabricated as described in paragraph 4, above, they should be laid out and routed in accordance with a plan applicable to the specific installation. Since cable layout and routing details must vary from installation to installation, no such details are given here. The general plan shown in figure 3-9, for a shore radio beacon, or figure 3-10, for a shipboard radio beacon, should be adapted to fit specific requirements. Cables may be routed in trenches, ducts, or overhead cable racks. The objectives are to limit total cable lengths to the maximum lengths specified above, to bring cable terminations to within connecting distance of the components involved, and to secure cable runs with clamps or other suitable means, so as to prevent damage due to cable movements.

The cables intended for connection to the receiver-transmitter group and to the power supply assembly group are brought into the equipment through cutouts provided in the cable entrance box. Cover plates are secured by means of hex bolts over these cutouts. The cutouts are intended to provide cable entrance to the interior of the box. To introduce the interconnecting cables into the equipment, and to prepare for making the connections, proceed as follows:

(1) Open the amplifier-modulator and frequency multiplier-oscillator drawers of the receiver-transmitter group and the high-voltage power supply unit just above the transformer and blower compartment of the power supply assembly as far as they will go.

CAUTION

Unless it has been bolted in place, the cabinet may topple over if too many drawers are left open.

(2) Remove the screws securing the sides of the cabinet to the frame and lift off the sides of the cabinet.

(3) Release the four knurled thumbscrews securing the lower portion of the ventilating duct inside the cabinet. Push down on that section of the duct to disengage it from the retaining clamps, and move it aside to gain access to the front of the terminal boards in the cable entrance box.

(4) Use a hex-wrench to remove the bolts securing the cover plate over the cutout selected to provide cable entrance. Remove the cover plate. Fit the cover plate(s) with stuffing tubes, as required.

(5) Feed the cables into the stuffing tubes and then into the equipment through the cutout, guiding the cables so that the terminals appear inside the cabinet frame near the front of the cable entrance box terminal boards. Fan out the individual cables and leads as required for making the connections to the individual terminal boards. Restore the cover plates.

CAUTION

Be careful not to damage any of the cables or components while doing work inside the cabinet.

b. CABLE CONNECTIONS. - Detailed interconnection information for Radio Set AN/GRN-9 is given in table 3-1. Tables 3-2 and 3-3 provide corresponding data for Radio Sets AN/GRN-9A and AN/SRN-6. Most of the connections are to be made to terminal boards with screw-type terminals. An r-f coaxial cable(type RG-18A/U shore or RG-118/U shipboard), fitted with a plug type UG 1041A/U shore or UG-926A/U shipboard at each end, is to be attached between a coaxial connector on the antenna base, and a connector on the front panel of Control-Duplexer C-2225/SRN-6 or C-2226/GRN-9. Two r-f coaxial cables type RG-10/U, fitted with a type UG-943A/U plug at each end, are to be connected between the cable entrance box on the receiver-transmitter group cabinet and the antenna base. A high-voltage power cable, type RG-27/U, is to be connected between binding posts in the transmitter-receiver group and power supply assembly cable entrance boxes. Finally, at shore installations, jumpers are to be connected between terminals on terminal boards in the receiver-transmitter group cable entrance box. To make the connections outlined above, proceed as follows:

CAUTION

Three-phase power connections are made to terminals 116, 117, and 118 of TB902. Before connecting power, check the phase rotation of the line, so that after connection, the antenna spin motor and the cooling blowers of the receiver-tranmitter and power supply-test set groups will rotate in the proper directions. (The antenna

CAUTION (Cont'd)

should rotate counterclockwise, as seen when looking up from the bottom of the antenna base.)

c. SHORE INSTALLATIONS. - Refer to table 3-1 or 3-2 for interconnection and wiring details for Radio Sets AN/GRN-9 or AN/GRN-9A, respectively.

(1) TERMINAL BOARD CONNECTIONS. - Connect the terminal lugs on the cables brought into the cable entrance boxes in accordance with paragraph 4c, above, to the terminals on the cable entrance box terminal boards in the receiver-transmitter group and power supply-test set group. Similarly, connect the cable leads to the terminal boards on the other equipment components.

(2) POWER CABLE CONNECTIONS.

(a) Connect one end of the high-voltage power cable RG-27/U to binding post E903 in the receiver-transmitter group cable entrance box. Connect the cable armor to ground at terminal 140 on TB903.

CAUTION

Make sure that the areas around binding posts E903 and E1001 are cleared of all other cable leads.

(b) Connect the other end of the power cable to binding post E1001 in the power supply-test set group cable entrance box. Connect the armor at that end of the cable to ground at terminal 384 on TB1004.

(3) COAXIAL CABLE CONNECTIONS.

(a) RF cable RG-18A/U is fitted with a type 1041A/U plug at the antenna end, and a type 154A/U at the equipment end. Connect one end to connector J3302 on the (shore) antenna pedestal. Connect the other end of the cable to connector P1169, a type UG-216B/U, right-angle fitting. Connect the fitting to RF OUTPUT jack J1155 on the front panel of Control Duplexer C-2226/GRN-9 in the receiver-transmitter group. For further details refer to table 3-1 or 3-2.

(b) The two type RG-10/U r-f cables have been fitted with type UG-943A/U plugs at each end. One cable brings the 15-cps reference trigger and the other the 135-cps reference trigger to the receiver-transmitter group. Connect one of the cables between connector J904 on top of the receiver-transmitter group cable entrance box and connector J3303 on the antenna pedestal. This is the 15-cps reference trigger connection. Connect the other

cable between connector J903 on top of the receiver-transmitter group cable entrance box and connector J3304 on the antenna pedestal. This is the 135-cps reference trigger connection.

d. SHIPBOARD INSTALLATION (RADIO SET AN/SRN-6). - Refer to table 3-3 for interconnection and wiring details.

(1) TERMINAL BOARD CONNECTIONS. - The terminal boards to which connections are to be made may be identified with the aid of table 3-3.

(2) POWER CABLE CONNECTIONS. - Make the connections described in paragraph 5d (2), above.

CAUTION

Make sure that the areas around binding posts E903 and E1001 are cleared of all other cables.

(3) COAXIAL CABLE CONNECTIONS.

(a) Connect one end of r-f cable RG-118/U connector to connector J3002 on the antenna pedestal. Connect the other end of that cable to connector P1169, a right-angle fitting. Connect the fitting to J1155 on the front panel of Control-Duplexer C-2225/SRN-6 in the receiver-transmitter group.

(b) Connect one end of the 15-cps reference trigger cable type RG-10/U to connector J904 on top of the receiver-transmitter group cable entrance box. Connect the other end of the cable to connector J3001 on the antenna pedestal.

(c) Connect one end of the 135-cps reference trigger cable type RG-10/U to connector J903 on top of the receiver-transmitter group cable entrance box. Connect the other end of the cable to connector J3003 on the antenna pedestal.

6. ELECTRON TUBE INSTALLATION.

The following tubes should be installed after the receiver-transmitter group and power supply-test group have been fastened in place:

TUBE TYPE		UNIT	REFERENCE SYMBOL
AN/GRN-9	AN/GRN-9A AN/SRN-6		
836		Medium Voltage Power Supply	V1801 and V1802
8020		High Voltage Power Supply	V1901 through V1906
5D22		Amplifier-Modulator	V1301*

TUBE TYPE		UNIT	REFERENCE SYMBOL
AN/GRN-9	AN/GRN-9A AN/SRN-6		
4-1000A		Amplifier-Modulator	V1302*
371B		Amplifier-Modulator	V1303*
SAL-39 Klystron	SAL-89 Klystron	Amplifier-Modulator	V1304

*After installing the plate caps on tubes V1301, V1302, and V1303, tighten the setscrews located on the side of each cap.

a. INSTALLATION OF SAL-39A KLYSTRON IN RADIO SET AN/GRN-9. (See figure 3-14.) - The klystron V1304 (type SAL-39A) should be installed in accordance with the following procedure:

(1) Before installing the klystron, preset the spacings of the cavity rings to the approximate required distance, as determined by the assigned frequency. The spacing of the cavity tuning rings is determined by the special tuning chart provided with each klystron. A typical tuning chart is shown in figure 3-15.

CAUTION

Figure 3-15 is a sample chart. DO NOT USE that chart for presetting the cavity ring spacing. Use the chart supplied with the particular klystron being used.

(2) Note that as shown in figure 3-15 the chart contains three curves, one for each of the three cavities of the klystron. These are the klystron INPUT, MIDDLE, and OUTPUT cavities.

(3) After determining the channel at which the radio beacon is to operate, choose the appropriate transmitter frequency. Then, using the chart provided with the particular klystron, determine the proper spacing required for each of the three cavities. The proper spacing is determined from the calibration curve, by using the transmitter frequency as the ordinate of the curve and the spacing, in thousandths of an inch, between the inside surfaces of the flanges, as the abscissa.

(4) Using jaw-type micrometer calipers (Browne and Sharpe Type 250 or equivalent) to gage the spacing between rings, adjust each of the cavities. Use the adjusting wrench provided for this purpose. It is very important that the

flanges be moved parallel to each other while they are being tuned. This is accomplished by turning any one adjusting nut no more than one full turn, before turning the other nut of the corresponding flange by the same amount. This may necessitate repeated adjustments of the nuts until the desired parallel condition is obtained.

CAUTION

Some klystrons are shipped without the flexible filament leads attached. When attaching leads to the filament terminals, and tightening the setscrews to secure the leads to these terminals, extreme care should be exercised so as not to crack the filament rod seals. Refer to figure 3-16.

(5) Check that the cup shield provided with the klystron is over the klystron filament terminals. Remove the two back screws but not the two screws that will be facing the front when the klystron is in the amplifier-modulator. (The back screws are not accessible for removal when the tube is resting on the cradle and anode supports.)

(6) Pull the amplifier-modulator out to its fully extended position, and be sure that the slides lock the unit in this position. Open the access door and the hinged shield that covers the klystron filament terminals.

(7) Loosen the four cradle bolts and tilt the cradle forward, pushing the band up and to the rear of the compartment. Loosen the bolt holding the cradle to the chassis and push it all the way to the right.

(8) Place the klystron into the compartment, cathode end first, and position the anode end on the two anode supports. Allow the other end to rest on the cradle.

(9) Insert and tighten the four bolts in the anode plate. Secure the grounding strap to the anode.

(10) Position the cradle directly under the raised ring on the input cavity and tighten the band around the klystron.

(11) Tighten the bolt holding the cradle to the chassis and then tighten the four bolts on the cradle.

(12) Attach the r-f input and output cables.

CAUTION

Care must be taken when attaching the r-f output cable to the klystron to maintain equal torque on the two pin wrenches (see figure 3-16) in order that the torque required to tighten the connector is not applied to the r-f output terminal. The bend in the cable should be maintained so that the transverse force is not applied to the terminal.

(13) Remove the cup shield from the filament end of the klystron and attach the flexible leads to the terminals at the insulating bushing at the back of the compartment. Make sure to connect the lead from the heater-cathode terminal (marked HK) to the outer conductor of the coaxial connector. Connect the other heater terminal to the inner conductor.

b. INSTALLATION OF SAL-89 KLYSTRON IN RADIO SET AN/GRN-9A OR RADIO SET AN/SRN-6. (See figures 3-17 and 3-18.) - The procedure for installation of the SAL-89 klystron is identical to the procedure for installation of the SAL-39A klystron except for the connection of the grid lead to the SAL-89 klystron. After completion of the 13 steps listed under the previous paragraph 6b attach the flexible grid lead to the solid terminal on the cathode end of the SAL-89 klystron.

7. PREPARATION FOR INITIAL CHECKS AND ADJUSTMENTS.

After the equipment has been installed and interconnected as outlined above, and before proceeding with the initial adjustments outlined in paragraph 10 below, proceed as follows:

a. Check that all connections have been properly made.

b. Check the fuses, pilot lamps, and other removable items to be sure they are properly installed.

c. Inspect cables, drawers, panel-mounted components, particularly meters, to make sure that no damage has resulted during the installation.

d. Restore the equipment cabinets to their normal operating conditions.

(1) Replace the section of the ventilating duct removed for the connection of cables to the cable entrance box terminal boards.

(2) Restore the sides of each cabinet.

(3) Close the equipment drawer units which have been opened for the interconnection of incoming cables.

Note

Safety interlock switches along the equipment frames are held in the closed position when the drawers are fully closed, and are opened when the drawers are opened.

8. POWER DISTRIBUTION.

As an aid in checking the interunit connections made in accordance with the preceding instructions, a primary power distribution diagram for Radio Set AN/GRN-9 or AN/GRN-9A is shown in figure 7-2. Primary power distribution for Radio Set AN/SRN-6 is shown in figure 7-2.1.

9. INITIAL ADJUSTMENTS OF RADIO SET.

a. PRELIMINARY ADJUSTMENTS (RADIO SET UNENERGIZED).

(1) CRYSTAL. - The equipment is shipped with a crystal in place in the frequency multiplier-oscillator. (See figure 4-5.) This crystal should not be replaced unless it is necessary to change the channel. If the channel frequency is changed the equipment must be retuned. (See paragraph 3-13.)

CAUTION

When changing crystals the entire crystal oven assembly must be changed. Each crystal oven, with its associated crystal installed, is factory calibrated to insure that the oscillator frequency will be within 0.002 percent of the required frequency. Whenever the crystal in the oven is changed, it is necessary to recalibrate the crystal oven. Frequency measuring equipment available in the field is not capable of measuring frequency to the accuracy required for this calibration.

(2) INTERLOCKS. - Make certain that all panel screws are tight, so that the interlocks may function properly.

(3) INITIAL SWITCH SETTINGS. - Initially, the switches listed below should be set in the positions indicated.

SWITCH NAME OR PANEL MARKING	REFERENCE SYMBOL	LOCATION	INITIAL POSITION
EMERGENCY SWITCH	S901	Front panel of the receiver-transmitter group blower compartment	OFF (arrow pointing left or right).

SWITCH NAME OR PANEL MARKING	REFERENCE SYMBOL	LOCATION	INITIAL POSITION
MASTER SWITCH	S1101	Panel of control duplexer	OFF
CODER-INDICATOR	S601	Panel of coder-indicator	OFF
OFF-ON	S502	Panel of radio receiver	OFF
METER SELECTOR	S501	Panel of radio receiver	OFF
ANTENNA CONTROL	S1102	Panel of control-duplexer	OFF
FIL ON	S1108	Panel of control-duplexer	OFF
LV	S1601	Panel of low-voltage power supply	OFF
MV	S1801	Panel of medium-voltage power supply	OFF
HV	S1901	Panel of high-voltage power supply	OFF
BATTLE SHORT	S1107	Panel of control-duplexer	NOR
KLYSTRON BEAM VOLTAGE (Radio Set AN/GRN-9 only)	S1303	Klystron compartment of amplifier-modulator. (Remove front panel of amplifier-modulator. Switch S1303 located in upper left corner of compartment. See figure 3-14.)	1/3
SELECT ANTENNA POSITION	S606	Panel coder indicator.	STABILIZED for shipboard installations STOW for shore installations

b. INITIAL ENERGIZING. - The following procedure should be employed when energizing the equipment for the first time.

WARNING

Operation of this equipment involves the use of HIGH VOLTAGES which are dangerous to life. Operating personnel must at all times observe all safety regulations. Do not change tubes or make adjustments inside the amplifier-modulator or high-voltage power supply chassis with the HIGH VOLTAGE supply ON. Do not depend upon safety interlock switches for protection. Under certain conditions, dangerous potentials may exist in the circuit with power controls in the OFF positions because of charges retained by capacitors. To avoid shock and severe burns, always discharge and ground circuits before touching them. Never service or adjust the equipment without the presence or the assistance of another person capable of rendering first aid immediately.

CAUTION

Before energizing the equipment for the first time the controls of the radio beacon must be put in the initial positions listed in paragraph 3a above.

Step 1. Turn EMERGENCY SWITCH S901, on the bottom panel of receiver-transmitter group cabinet, to the right until it clicks into the ON position, that is, with the arrow pointing up or down.

Check that the white crystal oven indicating lights, OVEN, DS1403, and NORMAL, DS1402, on the panel of the frequency multiplier-oscillator are on. (See figure 4-5.)

Note

After the crystal oven has reached the proper operating temperature, the NORMAL light will go out. Thereafter the NORMAL light will turn on and off as the oven thermostat turns the heater on and off to maintain the oven temperature.

Step 2. Turn the MASTER SWITCH, S1101, on the panel of control-duplexer to the STANDBY position.

Check that the blue MAIN POWER ON lamp DS1102 on the control-duplexer lights. (See figure 4-2.)

Check that the amber AIR SWITCH OPEN lights DS1303 on the panel of amplifier-modulator and DS901 on the panel of the blower compartment of the receiver-transmitter cabinet (see figure 4-1), and DS1001 on the bottom panel of power supply-test set group (see figure 4-7) are NOT lit. When lit, these lights indicate that the blowers which operate the air switches are not working properly.

CAUTION

If the amber lights are on, the blowers may be rotating in the wrong direction. Shut off the equipment immediately. Reverse the rotation of the blower by interchanging the line wires on terminals 5 and 6 of TB902. Operating the equipment with the blowers rotating in the wrong direction may cause serious damage because of overheating.

Step 3. Snap the POWER ON switch, S502, on the panel of the radio receiver to the ON position. (See figure 4-3.)

Check that the POWER ON white light, DS501, on the radio receiver is lit.

Step 4. Snap the POWER ON switch, S601, on the coder-indicator panel, to the ON position. (See figure 4-4.)

Check that the white POWER ON light, DS601, on the panel of coder-indicator is lit.

Note

Check that all switches on the antenna control unit are in the ON position. These switches are intended for use during servicing, and are normally left in the ON position.

Step 5. Snap the ANTENNA CONTROL switch, S1102, on the panel of the control-duplexer to the ON position. (See figure 4-2.)

Check that the white ANTENNA CONTROL light, DS1103, on the panel of control-duplexer is lit.

Check that the antenna is rotating in a counterclockwise direction, as seen by looking up from the bottom of the antenna base.

CAUTIONS

1. If both the antenna and the ventilating blowers in the equipment cabinets are rotating in the wrong direction (i.e., the air switches fail to operate), interchange the power input leads at terminals 5 and 6 on TB902, in the back of the receiver-transmitter group cable entrance box.

2. If the antenna is NOT rotating in a counterclockwise direction, stop the equipment, and reconnect the antenna spin motor as follows:

   a. AT A SHORE INSTALLATION: Interchange the wires installed on terminals 113 and 114 of receiver-transmitter cabinet terminal box.

   b. AT A SHIPBOARD INSTALLATION: Interchange the wires installed on terminals 1 and 2 of terminal board TB902

3. If the blowers alone are rotating in the wrong direction (air switches fail to operate) interchange the leads at terminals 6 and 7 of terminal board TB1101 in the control-duplexer unit.

Check that the ANTENNA CONTROL lamp, DS602, on the coder-indicator panel is burning steadily. (See figure 4-4.) If this light blinks, there is trouble in the antenna or in the antenna control circuits.

Step 6. Snap the TRANS FIL switch S1108, on the control-duplexer panel, to the ON position. (See figure 4-2.)

Check that the following white lamps are lit:

a. FIL ON lamp DS1101 on the control-duplexer.

b. FIL lamp DS1301 on the amplifier-modulator.

c. FILAMENT lamp DS1401 on the frequency multiplier-oscillator.

Check that the blue LV MV READY lamp DS1605 on the low-voltage power supply lights after a one-minute time delay.

Step 7. Read the SUPPLY VOLTS meter on the control-duplexer. If the reading is 120 volts ac, proceed to the next step. If the reading is not 120

volts ac, open the control-duplexer drawer, loosen the locking screw on the ADJUST FOR 120V knob (located on the left side of the control-duplexer drawer), and adjust for a reading of 120 volts ac on the SUPPLY VOLTS METER.

Note

The SUPPLY VOLTS voltmeter, M1101, can also be used to check the control line voltage. This is done by holding the (spring-return) REG FIL BUS-LINE meter switch, S1106, in the LINE position. The line voltage, as read on the meter, should be 120 volts ±10 percent.

Step 8. Turn the MASTER SWITCH, S1101, to OFF and then immediately to ON. (See figure 4-2.)

Check that there is a one-minute delay before the blue LV MV READY light, DS1605, on the panel of the low-voltage power supply comes on.

Step 9. When the blue LV MV READY light comes on, snap the LV PS ON switch, S1601, on the panel of the low-voltage power supply to the ON position. (See figure 5-1.)

Check that the red LV light, DS1602 and the green, -375V light DS1601 on the panel of low-voltage power supply are lit. (See figure 5-1.) The green light indicates that the low-voltage power supply is delivering d-c power to the other transmitter units of the radio beacon.

Step 10. Check and adjust, if necessary, the low-voltage power supply output voltages. (Refer to paragraph 11 for the adjustment procedure.)

Step 11. Snap the MV switch, S1801, on the medium-voltage power supply panel to the ON position. (See figure 5-2.)

Check that the red +700V, +1000V light, DS1801, on the panel of medium-voltage power supply is lit.

Check that the amber MV OVERLOAD light, DS1803, on the medium-voltage power supply panel is not lit.

Check that lamp DS1802, located inside the power supply unit, is lit. To make this check open the power supply drawer unit, and temporarily lock the interlock switch, on the cabinet frame behind the panel, manually.

CAUTION

Dangerous voltages are present when lamp DS1802 is lit.

Step 12. Check and adjust, if necessary, the medium-voltage power supply output voltage. (Refer to paragraph 11.)

CAUTION

When starting the radio set for the first time, or when starting a radio set containing a klystron that has not been in use for a period of three months or more, the klystron must be aged before applying full power to it. Refer to paragraph 18 of this section for instructions on aging the klystron.

Step 13. Turn the MASTER SWITCH to OFF and then immediately to ON.

Check that there is a five-minute delay before the blue HV READY light DS1902 on the high-voltage power supply panel comes on.

Step 14. When the HV READY light, DS1902, comes on, snap the HV switch S1901 to ON. (See figure 5-3.)

Check that the red HV ON light, DS1901, on the high-voltage power supply panel is lit.

Check that the amber HV OVERLOAD light, DS1903, on the high-voltage power supply panel is not lit.

Check that the HV SUPPLY voltmeter M1302 on the amplifier-modulator panel reads approximately 12,000 volts. (See figure 4-6.)

Step 15. Check that the SET TO MAGNETIC VARIATION dial on the front panel of the coder-indicator is set to the correct number of degrees variation to compensate for the angular difference between true north and magnetic north. If adjustment is necessary, refer to paragraph 16d of this section.

Step 16. Check the setting of the ANTENNA POSITION SELECTOR switch on the front panel of the coder-indicator. For shore-based operation it should be in the STOW position. For shipboard operation it should be in the STABILIZED position.

Step 17. Set the METER SELECTOR switch on the front panel of the coder-indicator to SPEED. Check that the ANTENNA SERVOS METER reads in the green portion of its scale.

Step 18. For shipboard operation only, set the METER SELECTOR switch on the coder-indicator to the AZIMUTH, PITCH, and ROLL positions, and read the ANTENNA SERVOS meter for each position. Check that the ANTENNA

SERVOS meter reads in the green portion of the scale. A reading in the red portion of the meter scale is an indication of trouble in the antenna control circuits.

Note

Under normal operating conditions, the radio set is turned off and on by means of the MASTER SWITCH on the control-duplexer. All off-on switches, except those on the built-in test equipment, are left in the on position. When the MASTER SWITCH is turned to the ON position, the radio set will be energized with the proper time delays applied to the various power supplies. Whenever a radio set is being energized for the first time, or whenever tuning or troubleshooting operations are being performed on the radio set, it is best to follow the initial energizing procedure step by step.

10. SETUP OF BUILT-IN TEST EQUIPMENT.

Note

The power supply assembly is shipped without the built-in test equipment installed (see figure 1-7). At the time of installation the blank panel covering the upper half of the power supply assembly is removed, and the built-in test equipment is installed in its place.

a. INTERCONNECTIONS. - The physical arrangement of the TEST SETS in the power supply test set cabinet is shown in figure 4-7. The test equipment provided includes the following five units:

The test equipment interconnecting harness, shown schematically in figure 3-20B, is added to the power supply assembly at the time the built-in test equipment is installed.

The front panel connections required to perform the standard tests listed in paragraph b below are shown in figure 5-1. These connections are temporary, and are removed when testing is complete.

(1) Pulse-Sweep Generator SG-121A/URN-3 (Technical Manual NAVSHIPS 92745).

(2) Pulse Analyzer-Signal Generator TS-890/URN-3 (Technical Manual NAVSHIPS 92819).

(3) Power Meter-Pulse Counter TS-891/URN-3 (Technical Manual 92809).

(4) Switch-Test Adapter SA-420/URN-3 (Technical Manual NAVSHIPS 92809).

(5) Oscilloscope OS-54/URN-3 (Technical Manual 92778).

b. ADJUSTMENTS.

(1) Internal adjustments to the test equipments before use are given in the individual manuals shipped with the test equipment.

(2) The units are interconnected internally through a cable harness assembly to permit rapid connection for standard test procedures as selected by means of a built-in switching system. The switching system includes two four-position function switches located on the front panels of Oscilloscope OS-54/URN-3 and Power Meter-Pulse Counter TS-891/URN-3 and a two-position coaxial r-f switch on Switch-Test Adapter SA-420/URN-3. If the front panel connections called for in figure 5-1 are made, it is necessary only to manipulate the front panel controls to make the checks listed below. Note that the two function switches should be in the same position for any one of the tests.

SWITCH POSITION	PANEL NAME	TEST
1	OPERATING TEST	R-f peak power; Visual pulse shape; Output pulse count; Transmitter-spectrum.
2	RECEIVER SENSITIVITY	Reference burst pulse count; Squitter count.
3	DELAY SYSTEM	Overall zero-distance time delay; Video zero distance time delay.
4	GENERAL TEST	Maintenance testing.

Note

With the function switches in position 4, GENERAL TEST POSITION, all internal interunit connections except power connections are effectively disconnected and the test equipments are operated as individual units. For checks and adjustments not listed in the preceeding table, have the function switches set to position 4.

c. PRELIMINARY SETTING OF FRONT PANEL CONTROLS ON PULSE ANALYZER-SIGNAL GENERATOR TS-890/URN-3. (See figure 5-5.)

Note

Before making any tests with Pulse Analyzer-Signal Generator TS-890/URN-3, adjust that unit as described below.

(1) Set RF OUTPUT to 0 DBM.

(2) Set INPUT ATTEN. SELECTOR to maximum attenuation.

(3) Set BAND SHIFT switch to 0.

(4) Set MODULATION SELECTOR to CW.

(5) Set CHANNEL SELECTOR to the applicable channel.

Note

If the built-in crystal oscillator is to be used as the frequency generating source, omit steps (f), (g) and (h).

(6) Set MAIN TUNING control to the applicable channel.

(7) Set OSCILLATOR SELECTOR in the V. F. O. CALIBRATE position.

(8) Adjust V. F. O. CALIBRATE control until a zero beat is heard in headphone plugged into the V. F. O. CALIBRATE jack.

(9) Set the OSCILLATOR SELECTOR switch to either REF OSC. position for crystal control or to V. F. O. position depending on which oscillator is to be used as the generating source.

(10) Adjust the ZERO SET control for a 0 reading on the OUTPUT LEVEL INDICATOR.

(11) Set the INTERROGATE switch to ON.

Note

Before proceeding with the next step, Pulse-Sweep Generator SG-121A/URN-3 must be energized and warmed up for at least two minutes.

(12) Adjust the POWER SET control on the TS-890/URN-3 and the PULSE AMPLITUDE control on the SG-121A/URN-3 for a midscale (100) reading on the OUTPUT LEVEL INDICATOR. Retune the CHANNEL control slightly, and recheck setting of POWER SET control for midscale reading on OUTPUT LEVEL INDICATOR.

(13) Adjust the ZERO SET (of power comparison indicator) for zero reading on the POWER COMPARISON INDICATOR.

(14) Set the MODULATION SELECTOR switch to the PULSE position.

Note

The TS-890 is now ready for special tests. Upon completion of the test, shut equipment down by turning the INTERROGATE and POWER switches to the OFF position.

11. ADJUSTMENT OF POWER SUPPLIES.

a. LOW-VOLTAGE POWER SUPPLY.
(See figure 7-11.13.)

(1) Turn the selector switch, S1402, under the DC SUPPLY VOLTAGE meter, M1402 on the panel of the frequency multiplier-oscillator, to positions -375V and +250V. Note which voltages are not within tolerance and require adjustment. The permissible tolerance for each voltage is ±10 volts.

(2) The low-voltage power supply adjustment potentiometers, R1623 (+250V), and R1663 (-375V), are located inside the drawer unit on the side of the chassis, and are marked with the voltages which they control. To make the adjustments, open the drawer unit, loosen the hex nut which locks the potentiometer shaft in the adjusted position, manually operate the interlock (see note, below), and use a screwdriver to adjust the potentiometer until the proper voltage reading is obtained on the DC SUPPLY VOLTAGE meter on the panel of the frequency multiplier-oscillator. Tighten the hex nut to secure the potentiometer in the adjusted position. Be careful not to change the potentiometer setting while tightening the locknut. After all adjustments have been made, close the drawer unit. The interlock will be released automatically.

Notes

(a) When the drawer unit is opened, the interlock switch, located on the cabinet frame behind the panel, will open and disconnect power to the power supply unit. Operate this switch manually before making the adjustments. To do that push the interlock pin gently to the side and pull it out until it catches.

(b) Ordinarily, the power supply assembly will be located near enough to the receiver-transmitter group so that meter M1402 on the frequency multiplier-oscillator

Notes (Cont'd)

panel may be observed while making the adjustments of the low-voltage power supply. If, however, this is not possible, the adjustment must be made by two technicians. The sound-powered telephones (outlets provided on front of the units) may be used for communication between the two groups, if necessary.

b. ADJUSTMENT OF MEDIUM-VOLTAGE POWER SUPPLY. (See figure 7-11.3.)

(1) Turn the selector switch, S1402, under the DC SUPPLY VOLTAGE voltmeter, M1402, on the panel of frequency multiplier-oscillator to positions +700V, +1000V, in turn. Note which voltages are out of tolerance and will require adjustment. The permissible tolerance is ±20 volts.

(2) The medium-voltage power supply adjustment potentiometer R1842 (+1000V), is located inside the power supply drawer unit on top of the chassis and is marked with the voltage which it controls. Note that the +700-volt output does not have an adjustment, but is determined by the screen current of V1302 in the amplifier-modulator unit. A reading of approximately 800 volts is normal under conditions of normal duty cycle. To make the adjustments, open the drawer unit, loosen the hex nut which locks the potentiometer shaft in the adjusted position, manually operate the interlock switch (see notes, following paragraph 11a (2) above) and use a screwdriver to adjust the potentiometer until the proper voltage reading is obtained on the DC SUPPLY VOLTAGE meter on the frequency multiplier-oscillator panel. Tighten the hex nut to secure the potentiometer in the adjusted position. Be careful not to change the potentiometer setting while tightening the nut. After both adjustments have been made, close the drawer unit.

12. CONTROL-DUPLEXER ADJUSTMENTS.

a. ADJUSTMENT OF FILAMENT VOLTAGE. (See figure 3-21.) - The regulated filament voltage should be adjusted to exactly 120 volts. To do this, proceed as follows:

(1) Open the control-duplexer drawer unit.

(2) Locate the ADJUST FOR 120V knob on the left side towards the rear of the control-duplexer.

(3) Loosen the locking screw under the ADJUST FOR 120V knob.

(4) Turn the ADJUST FOR 120V knob until 120 volts is read on the SUPPLY VOLTS meter M1101.

(5) Tighten the locking screw.

b. ADJUSTMENT OF PRESELECTOR CAVITIES. - Open the control-duplexer drawer to gain access to the cavity heads of preselector Z1153. Adjust the micrometer heads according to the data listed for the particular operating channel in table 3-4.

c. ADJUSTMENT OF TRANSMISSION LINE FILTER. - The transmission line filter is adjusted in conjunction with the tuning of the klystron output stage. When tuning the cavities for the first time, or when tuning the radio set to a new channel, the cavities should be preset to the approximate adjustment according to the tuning curves shown in figure 3-22. Remove the tuning screw covers to expose the tuning screws. (See figure 3-23.)

For touch-up tuning or when changing to an adjacent channel, it is not necessary to preset the cavities according to the tuning curves. A slight adjustment for maximum output signal at the ANTENNA INCIDENT jack on the control-duplexer front panel is all that is necessary. There is an interaction between the tuning of the klystron, double-slug tuner Z1303, and transmission line filter Z1156. Therefore, an adjustment on any one of these units will require that the adjustment of the others be checked. Refer to the tuning procedure of the transmitter output stages for a step-by-step method of tuning the transmission line filter and associated circuits.

13. CHANGING CRYSTALS.

It may be necessary to change the channel frequencies used by the radio beacon. There are 126 crystal frequencies available for use. Refer to table 3-4 for a list of channel numbers and corresponding crystal frequencies.

To change crystals open the front panel tuning access door on the frequency multiplier-oscillator, and insert a crystal oven assembly containing the crystal of the desired frequency in the crystal oven socket. (See figure 4-5.) For channels 1 to 63 the low-band r-f chassis is used with the crystal oven assembly plugged into socket XY1501. For channels 64 to 126 the high-band r-f chassis is used with the crystal oven assembly plugged into socket XY1502.

CAUTION

When changing crystals, the entire crystal oven assembly must be replaced. Each crystal oven, with its associated crystal installed, is factory-calibrated to insure that the oscillator frequency will be within 0.002 percent of the required frequency. Whenever the crystal in the oven is changed, it is necessary to recalibrate the crystal oven assembly. Frequency measuring equipment available in the field is not capable of measuring frequency to the accuracy required for this calibration.

After changing crystals, retune the frequency multiplier-oscillator and output circuits as instructed in this section.

14. FREQUENCY MULTIPLIER-OSCILLATOR ADJUSTMENTS.

Note

If the desired output frequency falls between 962 mc and 1,024 mc, the low-band r-f chassis is used, power plug P1504 is connected to J1510, the receiver local oscillator signal cable, P1406, is connected to J1505, located on the side of the low-band tripler cavity, and plug P1401 on cable W1403 is connected to output jack J1503 on the low-band tripler cavity.

If the desired output frequency falls between 1,151 mc and 1,213 mc, the high-band r-f chassis is used, power plug P1504 is connected to J1509, and the receiver local oscillator signal cable, P1406, is connected to J1502 located on the side of the high-band tripler cavity and plug P1401 on cable W1403 is connected to the output jack J1503 on the high-band tripler cavity. (See figure 3-24.)

a. TUNING THE CARRIER FREQUENCY GENERATING CHAIN, RADIO SET AN/GRN-9 ONLY. (See figures 3-25 and 4-5.)

(1) Insert a crystal oven containing a crystal of the desired frequency into the crystal oven socket on the frequency multiplier-oscillator r-f chassis.

When a crystal oven is installed, both the OVEN and NORMAL lamps on the frequency multiplier front panel will light. Wait until the crystal oven reaches operating temperature, which is indicated by the NORMAL lamp going off, before proceeding with tuning. The normal lamp will turn on and off occasionally as the crystal oven temperature cycles through its normal operating temperature range.

CAUTION

> When changing frequency in the field, it is essential that the crystal oven and associated crystal be replaced as a unit.

(2) Set tuning meter switch S1401 to OSC and adjust oscillator tuning coil (L1502 high band, or L1513 low band) for a maximum reading on TUNING meter M1401.

(3) Set tuning meter switch S1401 to 1ST DOUBLER and adjust first doubler tuning coil (L1503 high band, or L1514 low band) for a maximum reading on TUNING meter M1401.

(4) Set tuning meter switch S1401 to 2ND DOUBLER and adjust second doubler tuning coil (L1509 high band, or L1519 low band) for a maximum reading on TUNING meter M1401.

(5) Set tuning meter switch S1401 to 3RD DOUBLER and adjust third doubler tuning capacitor (C1519 high band, or C1536 low band) for a maximum reading on TUNING meter M1401.

(6) Set tuning meter switch S1401 to TRIPLER and adjust the tuning screw on the tripler cavity (Z1501 high band or Z1504 low band; see figure 3-25) for a maximum reading on TUNING meter M1401. While tuning the tripler cavity, observe the TEST METER M501 on the receiver front panel with METER SELECTOR switch S501 in the CR201 and CR202 positions. If the crystal current for either CR201 or CR202 should exceed 1.0 milliampere (half-scale reading on the meter), open the frequency multiplier-oscillator drawer and adjust the receiver local oscillator jack (J1502 high band or J1505 low band) by moving the assembly in or out to bring the crystal current below half scale. After tripler tuning is completed, readjust this jack to set the average crystal current for CR201 and CR202 between 0.6 and 0.1 milliampere 30 to 50 microamperes reading on the meter).

(7) Set the tuning meter switch S1401 to AMPL and adjust the tuning screw on the first amplifier cavity (Z1502 high band or Z1505 low band) for a maximum reading on TUNING meter M1401.

(8) Set tuning meter switch S1401 to KLYSTRON INPUT INCID and adjust the tuning screw on the second r-f amplifier cavity (Z1503 high band or Z1506 low band) for a maximum reading on TUNING meter M1401. (See figure 3-25.)

(9) Connect the vertical input of Oscilloscope OS-54/URN-3 (or equivalent) to the KLYSTRON INPUT INCID jack J1409, and peak the tuning adjustments of the first and second r-f amplifiers as described in the two previous steps to obtain maximum pulse amplitude on the oscilloscope screen. This step completes the tuning of the carrier frequency generating chain.

Note

Since both the first and second amplifiers are pulsed, the TUNING meter readings for these stages give a broad indication of proper tuning. A more definite indication of proper tuning is obtained by observing a rectified sample of the output pulse on an oscilloscope.

When observing the signal at the KLYSTRON INPUT INCID jack the test lead to the oscilloscope should be terminated in a 50- to 70-ohm resistance. Termination of the test lead in a low impedance prevents distortion of the pulse. The pulse should appear as shown in figure 3-18.

b. TUNING THE CARRIER FREQUENCY GENERATING CHAIN, RADIO SETS AN/GRN-9A and AN/SRN-6. (See figure 3-26 and 4-5.)

Note

With switch S1401 in the TRIPLER and AMPL positions, TUNING meter M1401 will show a reading even though these stages are untuned. However, as the associated cavities are tuned through resonance a definite peak will occur in the meter reading.

(1) Follow the instructions in the preceding paragraph on tuning the carrier frequency generating chain for Radio Set AN/GRN-9, steps (1) through (5).

(2) Set METER SELECTOR switch S501, located on the front panel of the receiver, to CR201, and adjust the tuning screw on tripler cavity (Z1501 high band, or Z1504 low band; see figure 3-25) for a maximum reading on TEST METER M501. If the reading on TEST METER M501 exceeds midscale (50 microamps), open the frequency multiplier-oscillator drawer and adjust the receiver local oscillator output jack (J1502 high band, or J1505 low band) by moving the assembly in or out until TUNING METER M501 reads below midscale.

(3) Repeat the previous step until a maximum, which is below midscale, is obtained on TUNING METER M501, then adjust the receiver local oscillator jack (J1502 high band, or J1505 low band) to set the reading on TUNING METER M501 between 0.6 and 0.1 ma (between 30 and 50 microamps on the meter scale) with the TUNING METER switch S501 set to CR201 and CR202.

(4) Set tuning meter selector switch S1401 to AMPL and adjust the tuning screw on the first amplifier cavity (Z1502 high band, or Z1505 low band) for a maximum reading on TUNING meter M1401.

(5) Recheck the current through crystals CR201 and CR202 as described in step (3) above.

(6) Set tuning meter selector switch S1401 to KLYSTRON INPUT INCID and adjust the tuning screw on the second amplifier cavity (Z1503 high band, or Z1506 on low band) for a maximum reading on TUNING meter M1401.

(7) Connect the vertical input of Oscilloscope OS-54/URN-3 (or equivalent) to the KLYSTRON INPUT INCID jack J1409, and peak the tuning adjustments of the first and second r-f amplifiers described in the two previous steps to obtain maximum pulse amplitude on the oscilloscope screen.

Note

Since both the first and second amplifiers are pulsed, the TUNING meter readings for these stages are rather broad. A more definite indication of proper tuning is obtained by observing a rectified sample of the output pulse on an oscilloscope.

When observing the signal at the KLYSTRON INPUT INCID jack, the test lead to the oscilloscope should be terminated in a 50- to 70-ohm resistance.

Termination of the test lead in a low impedance prevents distortion of the pulse. The pulse should appear as shown in figure 3-18.

c. VIDEO CHASSIS ADJUSTMENTS. - Adjustable components in the frequency multiplier-oscillator video chassis are preset at the factory. Under normal conditions there is no need to check these adjustments at the time of installation. Detailed instructions on video chassis adjustments are included in Volume 2, Section 7.

15. RADIO RECEIVER R-824/URN ADJUSTMENTS.

Adjustment of the receiver should be performed after the OFF-ON switch S502 on the radio receiver panel has been set in the ON position, and after the POWER ON lamp, DS501, on the receiver panel has been on for 10 minutes.

a. POWER CHECKS.

(See figure 4-3.)

(1) Set METER SELECTOR switch S501, located on the front panel of the radio receiver, to B+, 200VFS. The meter should read 150 volts.

Note

200VFS means 200 volts full-scale deflection. Therefore, a meter reading of 75 represents 150 volts.

(2) If the meter reading is not 150 volts, adjust R507 (see figure 7-11.6) to obtain a reading of 150 volts.

(3) Set the METER SELECTOR switch to C-, 200VFS. The meter should read -105 ±5 volts.

Note

-200VFS represents -200 volts full-scale deflection. Therefore, a meter reading of 52.5 represents -105 volts.

b. SQUITTER CONTROL VOLTAGE CHECK AND ADJUSTMENT.

(1) Turn the METER SELECTOR switch first to the CR201 position and then to the CR202 position. In each case the meter should read about 1 milliampere (half-scale deflection).

(2) Turn the METER SELECTOR switch, S501, on the radio receiver panel, to SQUITTER CONTROL -10VFS. The meter should read about five volts (half-scale deflection) when the local oscillator is normal, that is, when a 1-milliampere reading is obtained for either the CR201 or the CR202 position of the METER SELECTOR switch.

(3) Disconnect the local oscillator input at connector J201. The meter should read approximately (no less than) 4 volts. Reconnect the local oscillator input at connector J201.

(4) Turn the METER SELECTOR switch to the B+, 200VFS position. The meter should read +150 ±5 volts (that is, 75 ±2.5 scale divisions). If necessary, adjust potentiometer R507 to obtain this reading. Potentiometer R507 is located on the right side of the radio receiver drawer unit chassis.

(5) Turn the METER SELECTOR switch to the C-, 200VFS position. The meter should read -105 ±5 volts (that is, 52.5 ±2.5 scale divisions).

c. SQUITTER RATE ADJUSTMENT.
(See figure 5-4.)

(1) Turn the FUNCTION SWITCH on Power Meter-Pulse Counter TS-891/URN-3 to position 2, RECEIVER SENSITIVITY.

(2) Set the COUNTER SELECTOR switch on the power meter-pulse counter to SQUITTER.

(3) Set the RANGE SWITCH on Power Meter-Pulse Counter TS-891/URN-3 to X10.

(4) The squitter rate as read on the PULSE COUNT METER should be 2,700 ±90 pulses per second.

(5) If the reading obtained in step 4 is not 2,700 ±90 pulses per second, carefully adjust PULSE COUNT CONTROL potentiometer R437, located on the video chassis, on the left side of the radio receiver drawer unit until a reading of 2,700 pulses per second is obtained on the PULSE COUNT METER.

16. CODER-INDICATOR CIRCUIT ADJUSTMENTS.

a. ADJUSTMENT OF 1,350-CPS IDENTIFICATION TONE OSCILLATOR.
(See figures 7-11.5 and 7-11.9.)

(1) Turn on the coder-indicator by turning the POWER switch, S601, on the panel of the coder-indicator to ON, and the BATTLE SHORT switch on the control-duplexer to INTLK SHORTED.

(2) Turn on the antenna, by turning the ANTENNA CONTROL switch, S1102, on the panel of control-duplexer to ON.

(3) Connect coaxial cable from TEST OUTPUT jack on coder-indicator to VERT SIG INPUT jack on Oscilloscope OS-54/URN-3.

(4) Connect coaxial test lead from SYNC OUTPUT jack on coder-indicator to EXT TRIG INPUT jack on Oscilloscope OS-54/URN-3.

(5) Open the coder-indicator drawer, and lower the video chassis.

(6) Locate switch S603 on the top of the video chassis. Set switch S603 to CONTINUOUS TONE.

(7) Lock in the signal on the oscilloscope with the sweep speed set to 4, 000 microseconds per inch.

(8) The auxiliary reference bursts will appear as heavy pulses with the tone pulse groups appearing as faint pulses which are spaced evenly between the auxiliary reference bursts. (See figure 7-13, waveform 24E.)
Count the number of tone pulse groups which occur between auxiliary reference bursts. If the 1, 350-cps identification tone oscillator is properly adjusted, nine tone pulse groups will appear between auxiliary reference bursts.

(9) If necessary, adjust L603 on the coder-indicator video chassis until nine tone pulse groups appear between auxiliary reference bursts.

(10) Set the oscilloscope sweep speed to 100 microseconds per inch, and lock in two identification pulse pairs on the oscilloscope screen.

(11) Adjust R798 on the coder-indicator video chassis until the spacing between the leading edges of the first pulses in each pulse-pair is 100 ±10 microseconds.

b. ADJUSTMENT OF THE NORTH AND AUXILIARY REFERENCE BURSTS. (See figures 7-11.5 and 7-11.9.)

(1) Refer to the previous paragraph, and perform steps (1) through (5).

(2) Remove plug P906 from jack J603 on coder-indicator video chassis.

(3) Lock in signal on Oscilloscope OS-54/URN-3 with the sweep speed set to 110 microseconds per inch. The north reference burst will appear on the oscilloscope screeen as a series of pulse-pairs. When the radio set is operating properly, the north reference burst consists of 12 ±1 pulse-pairs. (See figure 7-9, waveform 24A.)

(4) Locate potentiometer R675 on the coder-indicator video chassis. Loosen the shaft locking nut, and adjust to obtain 12 pulse-pairs on the oscilloscope screen. Note that turning the shaft clockwise decreases the number of pulse-pairs. Turning the shaft counterclockwise increases the number of pulse-pairs. While observing the north reference burst on the oscilloscope, turn the shaft of R675 clockwise to obtain 11 pulse-pairs, then turn the shaft counterclockwise to obtain 13 pulse-pairs. The correct setting of R675 is midway between the settings which provide 11 and 13 pulse-pairs. After R675 is set correctly, carefully tighten the locking screw.

(5) Check the spacing between the leading edge of the first pulse and the leading edge of the twenty-third pulse. This spacing should be 330 ±5 microseconds. (That is, three inches on the oscilloscope screen with the sweep speed set at 110 microseconds per inch.) If the spacing is incorrect, adjust coil L601 on the coder-indicator video chassis to obtain the correct spacing.

(6) Replace plug P906 in jack J603, and remove plug P905 from jack J604.

(7) Lock in the auxiliary reference burst with the sweep speed set to 40 microseconds per inch. When the radio set is operating properly, the auxiliary reference burst should consist of 6 ±1 pulse-pairs.

(8) Locate potentiometer R672 on the coder-indicator video chassis. Loosen the shaft locking nut, and adjust potentiometer R672 while observing the auxiliary reference burst on the oscilloscope. Turn the shaft clockwise until five pulse-pairs are obtained, then turn the shaft counterclockwise until seven pulse-pairs are obtained. The correct setting for R672 is midway between the settings which give five and seven pulse-pairs.

(9) Check the spacing between the leading edge of the first pulse and the leading edge of the eleventh pulse. This spacing should be 120 ±2 microseconds. (That is, three inches on the oscilloscope with the sweep speed set to 40 microseconds per inch.)

If the spacing is incorrect, adjust coil L602 on the coder-indicator chassis to obtain the correct spacing. After completing this step the north and auxiliary bursts are properly adjusted. Replace plug P905 in jack J604, and close the coder-indicator drawer.

c. SETTING THE IDENTIFICATION CALL CODE.

Note

For tactical reasons it may be necessary to change the identification call code. Whenever a new code is to be assigned to the radio beacon, reset the code according to the following instructions:

CAUTION

If it is required that the radio beacon provide bearing and distance information to aircraft during the time taken to set up the code, turn the BATTLE SHORT switch on the

CAUTION (Cont'd)

control-duplexer to the INTLK SHORTED position. The radio beacon will continue to transmit a signal normal in every way except for the absence of the identification call tone. After setting the code turn the BATTLE SHORT switch to the NOR. (normal operating) position.

(1) Loosen the four captive screws holding the coder-indicator in place, and slide the drawer forward. The code wheel and coder switch will be exposed on the right side of the drawer. (See figure 7-11.9.)

(2) Turn the coder switch (S 605) off. The coder switch is the toggle switch located below and to the right of the center of the keying wheel.

(3) Remove the hub nut from the keying wheel shaft by rotating the hub nut counterclockwise.

CAUTION

During removal of the keying wheel, care should be taken to lift the keying switch (S607) cam to prevent damage to the cam.

(4) Remove the keying wheel by pulling it forward with the handles provided.

(5) Starting with the segment indicated by the START CODE arrow, and going in the clockwise direction, set back the first three segments before starting the first code character.

(6) Set up the first character of the code, using one segment pulled out for each dot, three segments pulled out for each dash, and one segment set in for the space between dots and dashes. (See figure 4-8.)

(7) Continuing in a clockwise direction, set three segments in to provide one full space between characters.

(8) Set up the remaining characters of the code following the procedure outlined in steps 6 and 7.

(9) Replace the keying wheel and restore the coder-indicator drawer to operating position by reversing the procedure outlined in steps (1) to (4).

d. ADJUSTMENT FOR MAGNETIC VARIATION. (See figure 4-4.) - Check the reading of the magnetic variation dial to see that the correct compensation for magnetic north has been set in.

CAUTION

At shore installations, the servo motor on the antenna base must be loosened before compensation for magnetic north can be set in.

(1) At fixed shore installations, the antenna base and antenna assembly have been lined up with true north. During initial adjustments it is necessary to compensate for the angular difference between magnetic north and true north, as determined from charts for the particular geographic area. Once this compensation has been set in, further adjustments will not be necessary during normal operation.

(2) At shipboard installations, the antenna base and antenna assembly have been lined up with the fore-aft direction of the ship. Depending upon the geographic location of the ship, angular difference between magnetic north and true north must be compensated for. This is necessary because the ship's compass is calibrated to true north, whereas the 15-cps, or north reference for the aircraft, is oriented to magnetic north. Once the adjustment has been made, the bearing of the radio beacon to magnetic north will be automatically maintained by the gyro-compass of the ship within geographic limits. The bearing information transmitted to the aircraft will remain accurate, as long as the ship remains in areas within which the angular difference between true north and magnetic north remains approximately the same as that for which the magnetic variation unit has been set. Readjustments for magnetic variation must be made, whenever the angular difference changes appreciably, as determined from navigational charts and maps.

(3) To make the adjustments, proceed as follows:

(a) Rotate the dial lock of the magnetic variation subassembly fully counterclockwise until the main knob rotates freely.

(b) Set the required variation in degrees on the hairline of the dial, as follows:

1. For variations west of true north, rotate the dial toward increasing numbers, that is, from 0° up to 10°, 20°, etc.

2. For variations to the east of true north, rotate the dial from 0° (360°) down, that is, toward 350°, 340°, etc.

(c) Tighten the dial lock.

17. AGING THE KLYSTRON.

Note

A new klystron, or one that has not been energized within three months or more, must be aged according to the following procedure before being used.

a. SAL-39A KLYSTRON (USED IN RADIO SET AN/GRN-9). (See figure 3-14.)

(1) Operate the Klystron filament for 15 minutes.

(2) Set the KLYSTRON BEAM VOLTAGE switch S1303 to 1/3.

(3) Set the HV switch on the front panel of the high-voltage power supply to ON, and allow the klystron to operate for 15 minutes.

(4) Set HV switch to OFF, set the KLYSTRON BEAM VOLTAGE switch to 2/3, turn the HV switch back to ON, and allow the klystron to operate for 15 minutes.

(5) Set the HV switch to OFF, set the KLYSTRON BEAM VOLTAGE switch to NORMAL, set the HV switch to ON, and allow the klystron to operate for 15 minutes. The klystron is now ready for normal operation.

b. SAL-89 KLYSTRON (USED IN RADIO SETS AN/GRN-9A AND AN/SRN-6). (See figures 3-17 and 3-18.)

(1) Disconnect the r-f drive input to the klystron.

(2) Operate the klystron filament for 15 minutes.

(3) Turn potentiometer R1420, located on the frequency multiplier-oscillator video chassis, completely counterclockwise. (See figure 7-11.22.)

(4) Set the HV switch S1902 on the high-voltage power supply to ON. The klystron may arc internally and trip off the high-voltage overload relay but upon reapplication of high voltage, arcing should cease.

(5) After the high voltage has been applied to the klystron for five minutes, adjust R1420 until 10 milliamperes of beam current is indicated on CHARGING CURRENT meter M1301 located on the front panel of the amplifier-modulator.

(6) Every five minutes advance R1420 clockwise to provide incremental increases of 10 milliamperes of beam current, with a five-minute period between increments, until a beam current of approximately 100 milliamperes has been obtained.

(7) Set the HV switch to OFF and connect the r-f input cable to the r-f input jack on the klystron.

(8) The SAL-89 klystron is now properly aged. Check the setting of potentiometer R1420 by connecting the oscilloscope to the SHAPED PULSE jack on the front panel of the frequency multiplier-oscillator and adjusting R1420 clockwise until the skirts of the 3-5-microsecond shaped pulse are fully visible and the peak of the pulse is not limiting. If the pulse peak limits when R1420 is advanced to show the skirts of the pulse, adjust R1470 to obtain the maximum pulse amplitude possible without limiting. (See figure 3-7.)

18. TRANSMITTER OUTPUT CIRCUIT TUNING ADJUSTMENTS.

Note

If the klystron is being energized for the first time, or has not been energized during the past three months, it must be aged according to the procedure outlined in paragraph 17 of this section.

Note

To perform several of the steps listed in the following tuning procedures, it is necessary to detect the r-f carrier signal and observe the detected pulse on an oscilloscope. To preserve the pulse shape, the coaxial test lead from the oscilloscope to test jacks on the radio set must be terminated in a low impedance at the oscilloscope end. To provide this termination, connect a BNC type T-connector (UG-274A/U) to the oscilloscope end of the test lead, and connect a BNC type 50-ohm termination MX-554/U to the T-connector. (If an MX-554/U termination is not available, connect a 1/2-watt, 50- to 70-ohm resistor across the side jack of the T-connector.) This termination must be used when observing the signal at the KLYSTRON INPUT INCID and REFL jacks on the frequency multiplier-oscillator front panel, the KLYSTRON OUTPUT INCIDENT and REFLECTED jacks and the ANTENNA INCIDENT and REFLECTED jacks on the amplifier-modulator front panel.

Note

Before tuning the transmitter output circuits, the carrier frequency generating chain in the frequency multiplier-oscillator drawer must be tuned as directed in paragraph 14 of this section.

a. RADIO SET AN/GRN-9 (SAL-39A KLYSTRON POWER AMPLIFIER). (See figure 3-14.)

(1) Open the access door of the amplifier-modulator.

WARNING

The 12, 000-volt terminals of the klystron are covered by a shield. This shield must be in place at all times when the amplifier-modulator is energized.

(2) Move the beam voltage switch, S1303, to the NORMAL position.

(3) Turn the HV switch S1901 located on the panel of the high-voltage power supply, to the ON position. The HV SUPPLY meter, M1302, located on the amplifier-modulator panel should read approximately 12 kv, and the CHARGING CURRENT meter, M1301, should read approximately 200 milliamperes for a normal duty cycle (7, 200 pulses per second). If necessary, adjust potentiometer R1318 to obtain this reading.

Note

The charging current will not change with klystron tuning.

(4) Snap the HV switch, S1901, to the OFF position.

Note

A typical klystron chart is shown, for explanatory purposes only, in figure 3-15. DO NOT USE this chart for the adjustment described in the following step. Use the special chart provided with the individual klystron.

(5) Refer to the special klystron chart provided with the klystron. It will be noted that this chart shows three curves, one for each of the three cavities, INPUT, MIDDLE, and OUTPUT. The transmitter frequency will be found as the horizontal scale of the curve, and the spacing in thousandths of an inch between the inside surfaces of the flanges as the vertical scale of the curve.

(6) Choose the proper transmitter frequency, and record the proper spacing for each of the cavities.

(7) Check and readjust, if necessary, each of these cavities to the settings recorded, making use of the wrench provided for this purpose, and also an inside vernier caliper. It is very important that the flanges be kept parallel to each other. This is accomplished by not turning any one nut more than a full turn before turning the other nuts the same amount.

(8) Connect crystal detector E1152 in series with Oscilloscope OS-54/URN-3, to the monitoring jack, J1154, on the front panel of the control-duplexer marked ANTENNA INCIDENT.

(9) Set the KLYSTRON BEAM VOLTAGE switch S1303 to the 1/3 position.

(10) Turn the HV switch S1901 to ON. If presetting of the klystron has been done correctly, and the frequency multiplier-oscillator is properly tuned, an indication should be observed on the scope. Adjust each of the klystron cavities for maximum output by turning the nuts nearest the operator. The input cavity should be maximized first, being sure to keep the flanges parallel. Disregard pulse shape during this operation.

(11) Connect the oscilloscope directly to the KLYSTRON INPUT INCIDENT jack on the front panel of the frequency multiplier-oscillator. (Crystal detector E1152 is not used at this jack as the signal at this jack is detected by a crystal built into the frequency multiplier-oscillator.) Adjust the tuning screw on the second r-f amplifier cavity (Z1503 high band or Z1506 low band; see figure 3-25) for maximum pulse amplitude on the oscilloscope screen.

Note

When tuning the radio set for the first time, or when making a large change in output frequency, preset the resonant cavities of the transmission line filter according to the tuning curves shown in figure 3-22. Remove the tuning screw covers (see figure 3-23) and adjust the tuning disk for each cavity until the tuning screw is set to dimension T as setermined from tuning curves in figure 3-22.

When tuning the radio set to an adjacent channel, or when making a slight change in tuning, it is not necessary to preset the transmission line filter cavities.

(12) Connect the oscilloscope to KLYSTRON OUTPUT REFLECTED jack

J1152 through crystal detector E1152. Tune the first cavity (the cavity on the left as seen facing the right side of the control duplexer drawer) for a minimum indication on the oscilloscope. (See figure 3-23.)

(13) Connect the oscilloscope to the ANTENNA INCIDENT jack J1154 through crystal detector E1152. Tune the second cavity of the transmission line filter for a maximum indication on the oscilloscope. Retune the first and second cavities for a peak indication on the oscilloscope.

Note

> Since there is a slight interaction between the tuning of the first and second cavities of the transmission line filter, it may be necessary to repeat the preceding step to insure that the maximum output has been obtained.

(14) Set the HV switch to OFF, set the KLYSTRON BEAM VOLTAGE switch to NORMAL, and reset the HV switch to ON.

(15) Connect the oscilloscope to the KLYSTRON OUTPUT INCIDENT jack through crystal detector E1152 and adjust the double-slug tuner, Z1303, for maximum indication on the oscilloscope. (See figure 3-27.) As tuning of the double-slug tuner may affect klystron tuning, it will be necessary to touch up the klystron tuning for maximum output. While observing the pulse amplitude on the oscilloscope, adjust each cavity of the klystron for maximum pulse amplitude. The center cavity must be adjusted for the maximum amplitude possible without double peaking. (See figure 3-19.)

(16) Connect the oscilloscope to the ANTENNA INCIDENT jack through crystal detector E1152. Touch up the tuning of the resonant cavities in the transmission line filter for maximum output.

b. RADIO SETS AN/GRN-9A AND AN/SRN-6 (SAL-89 KLYSTRON POWER AMPLIFIER).

(See figure 3-17.)

(1) Refer to the klystron tuning chart provided with the klystron. Note that this chart shows three curves, one for each of the three klystron cavities, input, output and middle. The transmitter frequency will be found as the horizontal scale of the curve, and the spacing in thousandths of an inch between the inside surfaces of the flanges as the vertical scale of the curve. Record the proper spacing of each of the cavities.

(2) Adjust each of the klystron cavities to the settings recorded, making use of an inside vernier caliper to check spacing. It is very important that the flanges be kept parallel to each other. This is accomplished by not turning any one nut more than a full turn before turning the other nuts the same amount.

(3) Set the HV OFF ON switch S1902 to ON, and adjust R1420 (see figure 7-11.22) to set beam current as indicated by CHARGING CURRENT meter M1901 to 30 ma.

(4) Connect Oscilloscope OS-54/URN-3 to the KLYSTRON OUTPUT INCIDENT jack J1157 through crystal detector E1152. (E1152 is stored within the control-duplexer drawer.)

(5) If the presetting has been done correctly, and if the frequency multiplier-oscillator has been tuned properly, an indication should be observed on the oscilloscope. Adjust each of the cavities for maximum output by turning the nuts nearest the operator, being certain to keep the flanges parallel.

Note

It is not possible to double peak the SAL-89; therefore, it is not necessary to tune for pulse shape as in transmitters using the SAL-39A klystron.

(6) Connect the Oscilloscope OS-54/URN-3 to KLYSTRON INPUT INCIDENT jack J1409 on the front panel of the frequency multiplier-oscillator, and adjust the tuning screw on the second r-f amplifier cavity (Z1503 high band, or Z1506 low band; see figure 3-25) for maximum pulse amplitude on the oscilloscope screen.

(7) Connect Oscilloscope OS-54/URN-3 to the KLYSTRON OUTPUT REFLECTED jack J1152 through crystal detector E1152. Tune the first cavity of the transmitter r-f filter (the cavity on the left as seen facing the right side of the fully opened control duplexer drawer; see figure 3-23) for a minimum indication on the oscilloscope. Refer to figure 3-22 for the approximate setting of transmitter r-f filter cavities.

(8) Connect the oscilloscope to ANTENNA INCIDENT jack J1154 through crystal detector E1152. Tune the second cavity of the transmission line filter for a maximum indication on the oscilloscope. Retune the first and second cavities for a peak indication on the oscilloscope.

Note

Since there is a slight interaction between the tuning of the first and second filter cavities, it may be necessary to repeat the preceding step to insure that the maximum output has been obtained.

(9) Connect Oscilloscope OS-54/URN-3 to SHAPED PULSE jack J1405 on the front panel of the frequency multiplier-oscillator. Adjust R1420 until the skirts of the 3.5-μsec pulse are fully visible, and the peak of the pulse is not limiting. If the pulse peak limits when R1420 is advanced to show the skirts of the pulse, adjust R1470 to obtain the maximum pulse amplitude possible without limiting. (See figure 7-11.19.1)

(10) Connect Oscilloscope OS-54/URN-3 to the KLYSTRON OUTPUT INCIDENT jack J1157 through crystal detector E1152. Adjust potentiometer R1470 for maximum output pulse amplitude without limiting.

(11) Leaving the oscilloscope connected as directed in the previous step, adjust the double-slug tuner, Z1303 (see figure 3-25), for maximum indication on the oscilloscope. As tuning of the double-slug tuner may affect klystron tuning, it will be necessary to touch up the klystron tuning for maximum power output. While observing the indication on the oscilloscope, adjust each klystron cavity for maximum output, making certain that the klystron tuning flanges are parallel.

(12) Connect Oscilloscope OS-54/URN-3 to the ANTENNA INCIDENT jack J1154 through crystal detector E1152. Touch up the r-f filter cavity tuning for maximum indication on the oscilloscope.

(13) With the oscilloscope connected as directed in the previous step, lock in the auxiliary reference burst on the oscilloscope screen. Check that the amplitude of pulses remains constant throughout the reference burst. If the reference burst appears as shown in waveform c of figure 3-28, no further adjustment is necessary. If the reference burst appears as shown in either waveform a or b of figure 3-28, adjust R1471 on the frequency multiplier-oscillator video chassis (see figure 3-26) to obtain a constant amplitude for all pulses in the reference burst as shown in waveform c. The adjustment of R1470, as described in step 9, and the adjustment of R1471 are interdependent. If it has been necessary to adjust R1471 to minimumize droop, recheck the adjustment of R1470 by observing a single pulse on the oscilloscope and

touching up the adjustment of R1470 to obtain the maximum pulse amplitude possible, without limiting.

19. RADIO BEACON PERFORMANCE CHECKS.

After the equipment has been checked, aligned and adjusted as described in the preceding paragraphs, make the overall radio beacon performance checks described in Section 5, paragraphs 2 through 11. Use the built-in test equipment for these checks.

If all the requirements given for these checks are met, the radio beacon may be assumed to be in proper operating condition, and is ready to be turned over to operating personnel.

Note

Detailed procedures for checking the performance of the radio beacon are also covered in the Performance Standards Handbook furnished with the equipment.

TABLE 3-1.
WIRING LIST OF INTERCONNECTING CABLES FOR THE RADIO BEACON AN/GRN-9 SHORE INSTALLATIONS

Wire No	Function	Volts	Amps	Conductor Size (CM)	Color Code	From	To
INCOMING CABLES TO RECEIVER-TRANSMITTER GROUP FHFA-23 (35 ft maximum)							
1	3Ø input, phase "A"	208	31	22,800	Blk	*	FL901
2	3Ø input, phase "B"	208	31	22,800	R	*	FL902
3	3Ø input, phase "C"	208	31	22,800	Gn	*	FL903
4	3Ø neutral	208	31	22,800	W	*	FL906
DSGA-4 (35 ft. maximum)							
1	Auxiliary power input	117	15	4497	Blk	*	FL904
2	Auxiliary power input	117	15	4497	W	*	FL905
CABLES BETWEEN RECEIVER-TRANSMITTER GROUP AND POWER SUPPLY TEST SET GROUP							
MSCA-30 (5 ft. maximum distance between units; 35 ft. maximum cabling)							
1	12KV Ground	Gnd		1779	Blk	TB1004 (1)	TB903 (1)
2	1 Min. delay ckt.	120	0.05	1779	W	TB1003 (1)	TB908 (19)
3	1 Min. delay coil	120		1779	R	TB1004 (12)	TB908 (17)
4	5 Min. delay coil	120		1779	Gn	TB1004 (14)	TB908 (14)
5	Remote "Ready" Indicator	120		1779	O	TB1004 (16)	TB907 (13)
6	Control ckt. neutral	120	0.94	1779	Blu	TB1003 (12)	TB907 (3)

TABLE 3-1 (cont'd)

Wire No.	Function	Volts	Amps	Conductor Size (CM)	Color Code	From	To
7	Chassis ground	Gnd		1779	W-Blk	TB1002 (12)	E999 (9)
8	Spare			1779	R-Blk		
9	Interlock, ckt.	120	0.32	1779	Gn-Blk	TB1003 (15)	TB907 (7)
10	Spare			1779	O-Blk		
11	Cab. blower, B901; phase "A"	208	3.1	1779	Blu-Blk	TB1001 (18)	TB908 (8)
12	Interlock ckt.	120	0.48	1779	Blk-W	TB1003 (17)	TB907 (10)
13	Spare			1779	R-W		
14	Spare			1779	Gn-W		
15	Cab. air switch ckt.	120	0.29	1779	Blu-W	TB1003 (20)	TB907 (12)
16	H. V. Interlock	120		1779	Blk-R	TB1002 (6)	TB908 (15)
17	Mod. SG relay coil ckt.	120	0.05	1779	W-R	TB1003 (2)	TB908 (20)
18	Spare			1779	O-R		
19	Automatic overload ckt.	120	0.3	1779	Blu-R	TB1003 (10)	TB907 (4)
20	Spare			1779	R-Gn		

* Shore input.

TABLE 3-1 (cont'd)

Wire No.	Function	Volts	Amps.	Conductor Size (CM)	Color Code	From	To
21	Spare			1779	O-Gn		
22	Control ckt.	120	0.94	1779	Blk-W-R	TB1003 (14)	TB907 (5)
23	Interlock ckt.	120	0.63	1779	W-Blk-R	TB1003 (18)	TB907 (9)
24	Cab. blowers, B1001, B901; phase "C"	208	3.1	1779	R-Blk-W	TB1001 (17)	TB908 (7)
25	Spare			1779	Gn-Blk-W		
26	Spare			1779	O-Blk-W		
27	Spare			1779	Blu-Blk-W		
28	Spare			1779	Blk-R-Gn		
29	Cab., blowers, B1001, B901; phase "C"	208	3.1	1779	W-R-Gn	TB1001 (20)	TB908 (10)
30	H.V. indicator ckt.	120	0.15	1779	R-Blk-Gn	TB1003 (7)	TB908 (18)
MSCA-10 (5 ft. maximum distance between units; 35 ft. maximum cabling)							
1	+250, +300v ground	Gnd	0.46	1779	Blk	TB1004 (17)	E999 (2)
2	+1000v reg. from MVPS	+1000	0.41	1779	W	E1011	E907
3	Spare			1779	R		

TABLE 3-1 (cont'd)

Wire No.	Function	Volts	Amps.	Conductor Size (CM)	Color Code	From	To
4	+250v reg. from LVPS	+250	0.36	1779	Gn	TB1004 (18)	TB903 (11)
5	+1000v ground	Gnd	0.41	1779	O	TB1004 (8)	E999 (3)
6	+1000v reg. from MVPS	+1000	0.41	1779	Blu	E1011	E907
7	+1000v ground	Gnd	0.41	1779	W-Blk	TB1004 (8)	E999 (3)
8	Spare			1779	R-Blk		
9	+700v reg. from MVPS	+700	0.1	1779	Gn-Blk	E1010	E906
10	Spare			1779	O-Blk		
MSCA-7 (5 ft. maximum distance between units; 35 ft. maximum cabling)							
1	Spare			1779	Blk		
2	-375v reg. from LVPS	-375	0.14	1779	W	TB1004 (11)	TB903 (12)
3	-375v ground	Gnd	0.12	1779	R	TB1004 (13)	E999 (3)
4	Spare			1779	Gn		
5	Spare			1779	O		
6	Spare			1779	Blu		
7	Spare			1779	W-Blk		

TABLE 3-1(cont'd)

Wire No.	Function	Volts	Amps	Conductor Size (CM)	Color Code	From	To
FSGA-4 (5 ft. maximum distance between units; 35 ft. maximum cabling)							
1	12kv plate trans-primary (T1001) phase "A"	208	8.3	4497	Blk	TB1001 (12)	TB901 (2)
2	12kv plate trans-primary (T1001) phase "B"	208	8.3	4497	W	TB1001 (11)	TB901 (3)
3	12kv plate trans-primary (T1001) phase "C"	208	8.3	4497	R	TB1001 (14)	TB901 (4)
4	Plate trans. neutral	208	8	4497	G	TB1002 (5)	TB904 (13)
FSGA-4 (5 ft. maximum diatance between units; 35 ft. maximum cabling)							
1	Cab. convenience outlets	117	15	4497	Blk	TB1001 (9)	TB904 (9)
2	Cab. convenience outlets	117	15	4497	W	TB1001 (10)	TB904 (10)
3	Cab. convenience outlets	117	15	4497	R	TB1001 (8)	TB904 (4)
4	Cab. convenience outlets	117	15	4497	G	TB1001 (7)	TB904 (6)
FSGA-4 (5 ft. maximum distance between units; 35 ft. maximum cabling)							
1	3Ø neutral	120	10	4497	Blk	TB1002 (15)	TB901 (8)
2	PS-TS input, phase "C"	120	3.4	4497	W	TB1002 (14)	TB902 (1)

TABLE 3-1 (cont'd)

Wire No.	Function	Volts	Amps	Conductor Size (CM)	Color Code	From	To
3	PS-TS input, phase "A"	120	3.4	4497	R	TB1002 (13)	TB902 (3)
4	PS-TS input, phase "B"	120	3.4	4497	G	TB1002 (16)	TB902 (2)
FSGA-4 (5 ft. maximum distance between units; 35 ft. maximum cabling)							
1	Reg. fil. bus	120	4.6	4497	Blk	TB1002 (10)	TB904 (19)
2	L.V. & M.V. Pl. Trans.	120	3 4	4497	W	TB1002 (3)	TB904 (14)
3	Spare			4497	R		
4	Fil. bus neutral	120	4.5	4497	G	TB1002 (8)	TB904 (20)
TTHFWA-1 1/2 (5 ft. maximum distance between units; 35 ft. maximum cabling)							
1	Sound-powered telephone	60	100ua	704	Blk	TB903 (8)	TB1004 (19)
2	Sound-powered telephone	60	100ua	704	W	TB903 (10)	TB1004 (20)
3	Spare			704	R		
RG-27/U (5 ft. maximum distance between units; 35 ft. maximum cabling)							
1	12kv H.V. output	12kv	300ma			E903	E1001

TABLE 3-1 (cont'd)
CABLES BETWEEN RECEIVER-TRANSMITTER GROUP AND ANTENNA CONTROL UNIT

Wire No.	Function	Volts	Amps	Conductor Size (CM)	Color Code	From	To
TSGA-14 (100 ft. maximum)							
1	Power for antenna drive motor, phase "A"	208		14, 340	Blk	TB902 (3)	TB2117 (6)
2	Power for antenna drive motor, phase "C"	208		14, 340	W	TB902 (1)	TB2117 (8)
3	Power for antenna drive motor, phase "B"	208		14, 340	R	TB902 (2)	TB2117 (10)
MSCA-19 (100 ft. maximum)							
1	Bearing reference	117	0.01	1779	Blk	TB905 (5)	TB2112 (1)
2	Bearing reference	117	0.01	1779	W	TB905 (6)	TB2112 (2)
3	Bearing error indicator	0.2	100u	1779	R	TB906 (15)	TB2112 (3)
4	Bearing error indicator	0.2	100u	1779	Gn	TB906 (11)	TB2112 (4)
5	Warning light	120	0.05	1779	O	TB905 (3)	TB2112 (5)
6	Warning light DS602	120	0.05	1779	Blu	TB905 (4)	TB2112 (6)
7	1350 cps ref. voltage			1779	W-Blk	TB903 (13)	TB2112 (7)

TABLE 3-1 (cont'd)

Wire No.	Function	Volts	Amps	Conductor Size (CM)	Color Code	From	To
8	Tach test voltage			1779	R-Blk	TB903 (16)	TB2112 (8)
9	Spare			1779	Gn-Blk		
10	Spare			1779	O-Blk		
11	S1 of G602 to synchro capacitor 36 S1	90	0.02	1779	Blu-Blk	TB906 (20)	TB2113 (1)
12	S2 of G602 to synchro capacitor 36 S2	90	0.02	1779	Blk-W	TB906 (16)	TB2113 (2)
13	S3 of G602 to synchro capacitor 36 S3	90	0.02	1779	R-W	TB906 (9)	TB2113 (3)
14	S1 of G601 to synchro capacitor 1 S1	90	0.02	1779	Gn-W	TB906 (3)	TB2113 (4)
15	S2 of G601 to synchro capacitor 1 S2	90	0.02	1779	Blu-W	TB906 (8)	TB2113 (5)
16	S3 of G601 to synchro capacitor 1 S3	90	0.02	1779	Blk-R	TB906 (14)	TB2113 (6)
17	Speed Control Error Indicator			1779	W-R	TB903 (19)	TB2115 (9)
18	Speed Control Error Indicator			1779	O-R	TB903 (20)	TB2115 (10)
19	Ground			1779	Blu-R	E999 (5)	TB2113 (9)

TABLE 3-1 (cont'd)
CABLES BETWEEN RECEIVER-TRANSMITTER GROUP AND ANTENNA CONTROL UNIT (cont'd)

Wire No.	Function	Volts	Amps	Conductor Size (CM)	Color Code	From	To
FSGA-9 (100 ft. maximum)							
1	Antenna control power	120	0.8	9016	Blk	TB904 (3)	TB2115 (1)
2	Conv. Outlet	117	10	9016	W	TB904 (6)	TB2115 (3)
3	Antenna control power	120	0.8	9016	R	TB904 (5)	TB2115 (2)
4	Conv. Outlet	117	10	9016	Gn	TB904 (4)	TB2115 (4)
TTHFWA-1 1/2 (100 ft. maximum)							
1	Sound-powered telephone	60uv	100ua	704	Blk	TB903 (8)	TB2113 (7)
2	Sound-powered telephone	60uv	100ua	704	W	TB903 (10)	TB2113 (8)
3	Spare			704	R		
CABLES BETWEEN ANTENNA CONTROL UNIT AND ANTENNA TSGA-14 (150 ft. maximum)							
1	3ϕ motor power	150		14,340	Blk	TB2117 (1)	TB3304 (1)
2	3ϕ motor power	150		14,340	W	TB2117 (3)	TB3304 (3)
3	3ϕ motor power	150		14,340	R	TB2117 (5)	TB3304 (5)

TABLE 3-1 (cont'd)
MSCA-19 (150 ft. maximum)

Wire No.	Function	Volts	Amps	Conductor Size (CM)	Color Code	From	To
1	Bearing error common	0.2	200ua	1779	Blk	TB2114 (1)	TB3301 (8)
2	Bearing error 1 speed	0.2	100ua	1779	W	TB2114 (2)	TB3302 (1)
3	Bearing error 36 speed	0.2	100ua	1779	R	TB2114 (3)	TB3301 (7)
4	Bearing fixed phase 3	120	0.15	1779	Gn	TB2114 (6)	TB3301 (3)
5	Bearing fixed phase 1 and control phase 4	120	0.3	1779	O	TB2114 (5)	TB3301 (1)
6	Bearing control phase 2	120	0.15	1779	Blu	TB2114 (4)	TB3301 (2)
7	Speed control tachometer	50	0.25	1779	W-Blk	TB2114 (7)	TB3302 (7)
8	Speed control tachometer	50	0.25	1779	R-Blk	TB2114 (8)	TB3302 (8)
9	Spare			1779	Gn-Blk		
10	Spare			1779	O-Blk		
11	Control transformer 36 S3 to differential generator 36S1	90	0.02	1779	Blu-Blu	TB2113 (1)	TB3301 (4)
12	Control transformer 36 S2	90	0.02	1779	Blk-W	TB2113 (2)	TB3301 (5)

TABLE 3-1
MSCA 19 (150 ft. maximum) (cont'd)

Wire No.	Function	Volts	Amps	Conductor Size (CM)	Color Code	From	To
13	Control transformer 36 S1 to differential generator 36 S3	90	0.02	1779	R-W	TB2113 (3)	TB3301 (6)
14	Control transformer 1 S3 to differential generator 1 S1	90	0.02	1779	Gn-W	TB2113 (4)	TB3302 (2)
15	Control transformer 1 S2	90	0.02	1779	Blu-W	TB2113 (5)	TB3302 (3)
16	Control transformer 1 S1 to differential generator 1 S3	90	0.02	1779	Blk-R	TB2113 (6)	TB3302 (4)
17	Spare			1779	W-R		
18	Spare			1779	O-R		
19	Ground			1779	Blu-R	TB2113 (9)	TB3303 (7)
FSGA-9 (150 ft. maximum)							
1	Safety Switch	120	0.8	9016	Blk	TB2115 (5)	TB3303 (3)
2	Conv. Outlet	117	10	9016	W	TB2115 (3)	TB3303 (5)
3	Safety switch	120	0.8	9016	R	TB2115 (6)	TB3303 (4)
4	Conv. Outlet	117	10	9016	Gn	TB2115 (4)	TB3303 (6)
TTHFWA-1 1/2 (150 ft. maximum)							
1	Sound power telephone	60mv	100ua	704	Blk	TB2113 (7)	TB3303 (1)

TABLE 3-1 (cont'd)
TTHFWA-1 1/2 (150 ft. maximum) (cont'd)

Wire No.	Function	Volts	Amps	Conductor Size (CM)	Color Code	From	To
2	Sound power telephone	60mv	100ua	704	W	TB2113 (8)	TB3303 (2)
3	Spare			704	R		

TABLE 3-1 (cont'd)
CABLES BETWEEN ANTENNA AND RECEIVER TRANSMITTER GROUP

(150 ft. maximum)					
RECEIVER TRANSMITTER GROUP JACK	CABLE PLUG	CABLE TYPE	FUNCTION	CABLE PLUG	ANTENNA JACK
J1155 UG-259/U, Type HN-LC	P1169 to UG-216B/U, Type LC connects to P1170 UG-154A/U, Type LC	RG-18A/U	RF input and output.	P3309 UG-1041A/U Type HN	J3302 UG-427B/U Type HN
J904 UG-701/U, Type C	P902 UG-943A/U Type C	RG-10/U	15 cps reference trigger.	P3310 UH-943A/U, Type C	J3303 UG-704/U, Type C
J903 UG-701/U, Type C	P901 UG-943A/U, Type C	RG-10/U	135 cps reference trigger.	P3311 UG-943A/U, Type C	J3304 UG-704/U, Type C

NOTE: The connectors are supplied with the equipment but the cable is not.

TABLE 3-2. WIRING LIST OF INTERCONNECTING CABLES FOR SHORE RADIO BEACONS WITH RADIO SETS AN/GRN-9A

INCOMING CABLES TO RECEIVER-TRANSMITTER GROUP OA-1534/GRN-9A							
FHFA-23 (35 ft maximum)							
Wire no.	Function	Volts	Amps	Conductor Size (CM)	Color Code	From	To
1	3∅ input, phase "A"	208	31	22,800	Blk	*	FL901
2	3∅ input, phase "B"	208	31	22,800	R	*	FL902
3	3∅ input, phase "C"	208	31	22,800	Gn	*	FL903
4	3∅ neutral	208	31	22,800	W	*	FL906
	DSGA-4 (35 ft maximum)						
1	Auxiliary power input	117	15	4497	Blk	*	FL904
2	Auxiliary power input	117	15	4497	W	*	FL905
	CABLES BETWEEN RECEIVER-TRANSMITTER GROUP OA-1534/GRN-9A AND POWER SUPPLY ASSEMBLY OA-1537/GRN-9A						
	MSCA-30 (5 ft maximum distance between units; 35 ft maximum cabling)						
1	12kv ground	Gnd		1779	Blk	TB1004 (1)	TB903 (1)
2	1 min delay ckt	120	0.05	1779	W	TB1003 (1)	TB908 (19)
3	1 min delay coil	120		1779	R	TB1004 (12)	TB 908 (17)
4	5 min delay coil	120		1779	Gn	TB1004 (14)	TB908 (14)
5	Remote "ready" indicator	120		1779	O	TB1004 (16)	TB907 (13)
6	Control ckt neutral	120	0.94	1779	Blu	TB1003 (12)	TB907 (3)
7	Chassis ground	Gnd		1779	W-blk	TB1002 (12)	E999 (9)
8	Spare			1779	R-blk		
9	Interlock ckt	120	0.32	1779	Gn-blk	TB1003 (15)	TB907 (7)
10	Spare			1779	O-blk		
11	Cab.blower, B1001 phase "A"	208	3.1	1779	Blu-blk	TB1001 (18)	TB908 (8)

*Shore input.

TABLE-3-2. WIRING LIST OF INTERCONNECTING CABLES FOR SHORE RADIO BEACONS WITH RADIO SETS AN/GRN-9A (Cont'd)

CABLES BETWEEN RECEIVER-TRANSMITTER GROUP OA-1534/GRN-9A AND POWER SUPPLY ASSEMBLY OA-1537/GRN-9A							
MSCA-30 (5 ft maximum distance between units; 35 ft maximum cabling)							
Wire no.	Function	Volts	Amps	Conductor Size (CM)	Color Code	From	To
12	Interlock ckt	120	0.48	1779	Blk-W	TB1003 (17)	TB907 (10)
13	Spare			1779	R-W		
14	Spare			1779	Gn-W		
15	Cab. air switch ckt	120	0.29	1779	Blu-W	TB1003 (20)	TB907 (12)
16	HV interlock	120		1779	Blk-R	TB1002 (6)	TB908 (15)
17	Spare			1779	W-R		
18	Spare			1779	O-R		
19	Automatic overload ckt	120	0.3	1779	Blu-R	TB1003 (10)	TB907 (4)
20	Spare			1779	R-Gn		
21	Spare			1779	O-Gn		
22	Control ckt	120	0.94	1779	Blk-W-R	TB1003 (14)	TB907 (5)
23	Interlock ckt	120	0.63	1779	W-Blk-R	TB1003 (18)	TB907 (9)
24	Cab. blowers, B1001, phase "B"	208	3.1	1779	R-Blk-W	TB1001 (17)	TB908 (7)
25	Spare			1779	Gn-Blk-W		
26	Spare			1779	O-Blk-W		
27	Spare			1779	Blu-Blk-W		
28	Spare			1779	Blk-R-Gn		
29	Cab. blowers, B1001, phase "C"	208	3.1	1779	W-R-Gn	TB1001 (20)	TB908 (10)
30	HV indicator ckt	120	0.15	1779	R-Blk-Gn	TB1003 (7)	TB908 (18)
	MSCA-10 (5 ft maximum distance between units; 35 ft maximum cabling)						
1	+250v ground	Gnd	0.46	1779	Blk	TB1004 (17)	E999 (2)

TABLE 3-2. WIRING LIST OF INTERCONNECTING CABLES FOR SHORE RADIO BEACONS WITH RADIO SETS AN/GRN-9A (Cont'd)

CABLES BETWEEN RECEIVER-TRANSMITTER GROUP OA-1534/GRN-9A AND POWER SUPPLY ASSEMBLY OA-1537/GRN-9A							
MSCA-10 (5 ft maximum distance between units; 35 ft maximum cabling)							
Wire no.	Function	Volts	Amps	Conductor Size (CM)	Color Code	From	To
2	+1000v reg from MVPS	+1000	0.41	1779	W	E1011	E907
3	Spare			1779	R		
4	+250v reg from LVPS	+250	0.36	1779	Gn	TB1004 (18)	TB903 (11)
5	+1000v ground	Gnd	0.41	1779	O	TB1004 (8)	E999 (3)
6	+1000v reg from MVPS	+1000	0.41	1779	Blu	E1011	E907
7	+1000v ground	Gnd	0.41	1779	W-Blk	TB1004 (8)	E999 (3)
8	Spare			1779	R-Blk		
9	Spare			1779	Gn-Blk		
10	Spare			1779	O-Blk		
	MSCA-7 (5 ft maximum distance between units; 35 ft maximum cabling)						
1	Spare			1779	Blk		
2	-375v reg from LVPS	-375	0.14	1779	W	TB1004 (11)	TB903 (12)
3	-375 ground	Gnd	0.12	1779	R	TB1004 (13)	E999 (3)
4	Spare			1779	Gn		
5	Spare			1779	O		
6	Spare			1779	Blu		
7	Spare			1779	W-Blk		
	FSGA-4 (5 ft maximum distance between units; 35 ft maximum cabling)						
1	12kv plate trans-primary (T1001) phase "A"	208	8.3	4497	Blk	TB1001 (12)	TB901 (2)
2	12kv plate trans-primary (T1001) phase "B"	208	8.3	4497	W	TB1001 (11)	TB901 (3)

TABLE 3-2. WIRING LIST OF INTERCONNECTING CABLES FOR SHORE RADIO BEACONS WITH RADIO SETS AN/GRN-9A (Cont'd)

CABLES BETWEEN RECEIVER-TRANSMITTER GROUP OA-1534/GRN-9A AND POWER SUPPLY ASSEMBLY OA-1537/GRN-9A							
FSGA-4 (5 ft maximum distance between units; 35 ft maximum cabling)							
Wire no.	Function	Volts	Amps	Conductor Size (CM)	Color Code	From	To
3	12kv plate trans-primary (T1011) phase "C"	208	8.3	4497	R	TB1001 (14)	TB901 (4)
4	Plate trans-neutral	208	8	4497	G	TB1002 (5)	TB904 (13)
FSGA-4 (5 ft maximum distance between units; 35 ft maximum cabling)							
1	Cab. convenience outlets	117	15	4497	Blk	TB1001 (9)	TB904 (9)
2	Cab. convenience outlets	117	15	4497	W	TB1001 (10)	TB904 (10)
3	Cab. convenience outlets	117	15	4497	R	TB1001 (8)	TB904 (4)
4	Cab. convenience outlets	117	15	4497	G	TB1001 (7)	TB904 (6)
FSGA-4 (5 ft maximum distance between units; 35 ft maximum cabling)							
1	3ϕ neutral	120	10	4497	Blk	TB1002 (15)	TB901 (8)
2	Test set input, 1ϕ phase "C"	120	3.4	4497	W	TB1002 (14)	TB902 (1)
3	Test set input, 1ϕ phase "A"	120	3.4	4497	R	TB1002 (13)	TB902 (3)
4	Test set input, 1ϕ phase "B"	120	3.4	4497	G	TB1002 (16)	TB902 (2)
FSGA-4 (5 ft maximum distance between units; 35 ft maximum cabling)							
1	Reg fil bus	120	4.6	4497	Blk	TB1002 (10)	TB904 (19)
2	LV & MV Pl Trans	120	3.4	4497	W	TB1002 (3)	TB904 (14)
3	Spare			4497	R		
4	Fil bus neutral	120	4.5	4497	G	TB1002 (8)	TB904 (20)

TABLE 3-2. WIRING LIST OF INTERCONNECTING CABLES FOR SHORE RADIO BEACONS WITH RADIO SETS AN/GRN-9A (Cont'd)

Wire no.	Function	Volts	Amps	Conductor Size (CM)	Color Code	From	To
CABLES BETWEEN RECEIVER-TRANSMITTER GROUP OA-1534/GRN-9A AND POWER SUPPLY ASSEMBLY OA-1537/GRN-9A							
TTHFWA-1 1/2 (5 ft maximum distance between units; 35 ft maximum cabling)							
1	Sound powered telephone	60	100ua	704	Blk	TB903 (8)	TB1004 (19)
2	Sound powered telephone	60	100ua	704	W	TB903 (10)	TB1004 (20)
3	Spare			704	R		
RG-27/U (5 ft maximum distance between units; 35 ft maximum cabling)							
1	12kv HV output	12kv	300ma			E903	E1001
CABLES BETWEEN RECEIVER-TRANSMITTER GROUP OA-1534/GRN-9A AND AMPLIFIER, ELECTRONIC CONTROL AM-1720/URN							
TSGA-14 (100 ft maximum)							
1	Power for antenna drive motor, phase "A"	208		14,340	Blk	TB902 (3)	TB2117 (6)
2	Power for antenna drive motor, phase "C"	208		14,340	W	TB902 (1)	TB2117 (8)
3	Power for antenna drive motor, phase "B"	208		14,340	R	TB902 (2)	TB2117 (10)
NSCA-19 (100 ft maximum)							
1	Bearing reference	117	0.01	1779	Blk	TB905 (5)	TB2112 (1)
2	Bearing reference	117	0.01	1779	W	TB905 (6)	TB2112 (2)
3	Bearing error indicator	0.2	100u	1779	R	TB906 (15)	TB2112 (3)
4	Bearing error indicator	0.2	100u	1779	Gn	TB906 (11)	TB2112 (4)
5	Warning light	120	0.05	1779	O	TB905 (3)	TB2112 (5)

TABLE 3-2. WIRING LIST OF INTERCONNECTING CABLES FOR SHORE RADIO BEACONS WITH RADIO SETS AN/GRN-9A (Cont'd)

CABLES BETWEEN RECEIVER-TRANSMITTER GROUP OA-1534/GRN-9A AND AMPLIFIER, ELECTRONIC CONTROL AM-1720/URN

Wire no.	Function	Volts	Amps	Conductor Size (CM)	Color Code	From	To
NSCA-19 (100 ft maximum)							
6	Warning light DS602	120	0.05	1779	Blu	TB905 (4)	TB2112 (6)
7	1350-cps ref voltage			1779	W-Blk	TB903 (1)	TB2112 (7)
8	Tach test voltage			1779	R-Blk	TB903 (16)	TB2112 (8)
9	Spare			1779	Gn-Blk		
10	Spare			1779	O-Blk		
11	S1 of G602 to synchro capacitor 36 S1	90	0.02	1779	Blu-Blk	TB906 (20)	TB2113 (1)
12	S2 of G602 to synchro capacitor 36 S2	90	0.02	1779	Blk-W	TB906 (16)	TB2113 (2)
13	S3 of G602 to synchro capacitor 36 S3	90	0.02	1779	R-W	TB906 (9)	TB2113 (3)
14	S1 of G601 to synchro capacitor 1 S1	90	0.02	1779	Gn-W	TB906 (3)	TB2113 (4)
15	S2 of G601 to synchro capacitor 1 S2	90	0.02	1779	Blu-W	TB906 (8)	TB2113 (5)
16	S3 of G601 to synchro capacitor 1 S3	90	0.02	1779	Blk-R	TB906 (14)	TB2113 (6)
17	Speed control error indicator			1779	W-R	TB903 (19)	TB2115 (9)
18	Speed control error indicator			1779	O-R	TB903 (20)	TB2115 (10)
19	Ground			1779	Blu-R	E999 (5)	TB2113 (9)
FSGA-9 (100 ft maximum)							
1	Antenna control power	120	0.8	9016	Blk	TB904 (3)	TB2115 (1)
2	Conv outlet	117	10	9016	W	TB904 (6)	TB2115 (3)
3	Antenna control power	120	0.8	9016	R	TB904 (5)	TB2115 (2)

TABLE 3-2. WIRING LIST OF INTERCONNECTING CABLES FOR SHORE RADIO BEACONS WITH RADIO SETS AN/GRN-9A (Cont'd)

Wire no.	Function	Volts	Amps	Conductor Size (CM)	Color Code	From	To
CABLES BETWEEN RECEIVER-TRANSMITTER GROUP OA-1534/GRN-9A AND AMPLIFIER, ELECTRONIC CONTROL AM-1720/URN							
FSGA-9 (100 ft maximum)							
4	Conv outlet	117	10	9016	Gn	TB904 (4)	TB2115 (4)
TTHFWA-1 1/2 (100 ft maximum)							
1	Sound-powered telephone	60uv	100ua	704	Blk	TB903 (8)	TB2113 (7)
2	Sound-powered telephone	60uv	100ua	704	W	TB903 (10)	TB2113 (8)
3	Spare			704	R		
CABLES BETWEEN AMPLIFIER, ELECTRONIC CONTROL AM-1720/URN AND PEDESTAL, ANTENNA AB-541/URN							
TSGA-14 (150 ft maximum)							
1	3∅ motor power	150		14,340	Blk	TB2117 (1)	TB3304 (1)
2	3∅ motor power	150		14,340	W	TB2117 (3)	TB3304 (3)
3	3∅ motor power	150		14,340	R	TB2117 (5)	TB3304 (5)
MSCA-19 (150 ft maximum)							
1	Bearing error common	0.2	200ua	1779	Blk	TB2114 (1)	TB3301 (8)
2	Bearing error 1 speed	0.2	100ua	1779	W	TB2114 (2)	TB3302 (1)
3	Bearing error 36 speed	0.2	100ua	1779	R	TB2114 (3)	TB3301 (7)
4	Bearing fixed phase 3	120	0.15	1779	Gn	TB2114 (6)	TB3301 (3)
5	Bearing fixed phase 1 and control phase 4	120	0.3	1779	O	TB2114 (5)	TB3301 (1)
6	Bearing control phase 2	120	0.15	1779	Blu	TB2114 (4)	TB3301 (2)
7	Speed control tachometer	50	0.25	1779	W-Blk	TB2114 (7)	TB3302 (7)

TABLE 3-2. WIRING LIST OF INTERCONNECTING CABLES FOR SHORE RADIO BEACONS WITH RADIO SETS AN/GRN-9A (Cont'd)

CABLES BETWEEN AMPLIFIER, ELECTRONIC CONTROL AM-1720/URN AND PEDESTAL, ANTENNA AB-541/URN							
MSCA-19 (150 ft maximum)							
Wire no.	Function	Volts	Amps	Conductor Size (CM)	Color Code	From	To
8	Speed control tachometer	50	0.25	1779	R-Blk	TB2114 (8)	TB3302 (8)
9	Spare			1779	Gn-Blk		
10	Spare			1779	O-Blk		
11	Diff gen 36 S1 to control transformer 36 S3	90	0.02	1779	Blu-Blk	TB2113 (1)	TB3301 (4)
12	Control transformer 36 S2	90	0.02	1779	Blk-W	TB2113 (2)	TB3301 (5)
13	Diff gen 36 S3 to control transformer 36 S1	90	0.02	1779	R-W	TB2113 (3)	TB3301 (6)
14	Diff gen 1 S1 to control transformer 1 S3	90	0.02	1779	Gn-W	TB2213 (4)	TB3302 (2)
15	Control transformer 1 S2	90	0.02	1779	Blu-W	TB2213 (5)	TB3302 (3)
16	Diff gen. 1 S3 to control transformer 1 S1	90	0.02	1779	Blk-R	TB2113 (6)	TB3302 (4)
17	Spare			1779	W-R		
18	Spare			1779	O-R		
19	Ground			1779	Blu-R	TB2113 (9)	TB3303 (7)
FSGA-9 (150 ft maximum)							
1	Safety switch	120	0.08	9016	Blk	TB2115 (5)	TB3303 (3)
2	Conv outlet	117	10	9016	W	TB2115 (3)	TB3303 (5)
3	Safety switch	120	0.8	9016	R	TB2115 (6)	TB3303 (4)
4	Conv outlet	117	10	9016	Gn	TB2115 (4)	TB3303 (6)

TABLE 3-2. WIRING LIST OF INTERCONNECTING CABLES FOR SHORE RADIO BEACONS WITH RADIO SETS AN/GRN-9A (Cont'd)

CABLES BETWEEN AMPLIFIER, ELECTRONIC CONTROL AM-1720/URN AND PEDESTAL, ANTENNA AB-541/URN							
TTHFWA-1 1/2 (150 ft maximum)							
Wire no.	Function	Volts	Amps	Conductor Size (CM)	Color Code	From	To
1	Sound-powered telephone	60mv	100ua	704	Blk	TB2113 (7)	TB3303 (1)
2	Sound-powered telephone	60mv	100ua	704	W	TB2213 (8)	TB3303 (2)
3	Spare			704	R		

CABLES BETWEEN PEDESTAL, ANTENNA AB-541/URN AND RECEIVER-TRANSMITTER GROUP OA-1534/GRN-9A					
(150 ft maximum)					
Receiver Transmitter Group Jack	Cable Plug	Cable Type	Function	Cable Plug	Antenna Jack
J1155 UG-259/U, Type HN-LC	P1169 to UG-216B/U, Type LC connects to P1170 UG-154/U, Type LC	RG-18A/U	R-f input and output	P3309 UG-1041A/U Type HN	J3302 UG-427B/U Type HN
J904 UG-701/U, Type C	P902 UG-943A/U, Type C	RG-10/U	15-cps reference trigger	P3310 UG-943A/U, Type C	J3303 UG-704/U, Type C
J903 UG-701/U, Type C	P901 UG-943/U Type C	RG-10/U	135-cps reference trigger	P3311 UG-943A/U Type C	J3304 UG-704/U, Type C

Note

The connectors are supplied with the equipment but the cable is not.

TABLE 3-3

WIRING LIST OF INTERCONNECTING CABLES
FOR SHIPBOARD RADIO BEACONS
WITH RADIO SET AN/SRN-6

TABLE 3-4

CHANNEL CRYSTAL FREQUENCIES AND PRESELECTOR MICROMETER CAVITY HEAD SETTINGS

CHANNEL NO.	CRYSTAL FREQUENCIES (MC)	RECEIVER FREQUENCY (MC)	TRANSMITTER FREQUENCY (MC)	MICROMETER CAVITY HEAD SETTING (MILS)
1	40.083333	1025	962	087
2	40.125000	1026	963	090
3	40.166667	1027	964	093
4	40.208333	1028	965	096
5	40.250000	1029	966	099
6	40.291667	1030	967	102
7	40.333333	1031	968	105
8	40.375000	1032	969	108
9	40.416667	1033	970	111
10	40.458333	1034	971	114
11	40.500000	1035	972	117
12	40.541667	1036	973	120
13	40.583333	1037	974	123
14	40.625000	1038	975	126
15	40.666667	1039	976	129
16	40.708333	1040	977	132
17	40.750000	1041	978	135
18	40.791667	1042	979	138
19	40.833333	1043	980	141

TABLE 3-4 (cont'd)

CHANNEL NO.	CRYSTAL FREQUENCIES (MC)	RECEIVER FREQUENCY (MC)	TRANSMITTER FREQUENCY (MC)	MICROMETER CAVITY HEAD SETTING (MILS)
20	40.875000	1044	981	144
21	40.916667	1045	982	147
22	40.985333	1046	983	150
23	41.000000	1047	984	153
24	41.041667	1048	985	156
25	41.083333	1049	986	159
26	41.125000	1050	987	162
27	41.166667	1051	988	164
28	41.208333	1052	989	167
29	41.250000	1053	990	170
30	41.291667	1054	991	173
31	41.333333	1055	992	176
32	41.375000	1056	993	179
33	41.416667	1057	994	182
34	41.458333	1058	995	185
35	41.500000	1059	996	188
36	41.541667	1060	997	190
37	41.583333	1061	998	194
38	41.625000	1062	999	197
39	41.666667	1063	1000	199
40	41.708333	1064	1001	202

TABLE 3-4 (cont'd)

CHANNEL NO.	CRYSTAL FREQUENCIES (MC)	RECEIVER FREQUENCY (MC)	TRANSMITTER FREQUENCY (MC)	MICROMETER CAVITY HEAD SETTING (MILS)
41	41.750000	1065	1002	205
42	41.791667	1066	1003	209
43	41.833333	1067	1004	211
44	41.875000	1068	1005	214
45	41.916667	1069	1006	218
46	41.958333	1070	1007	220
47	42.000000	1071	1008	223
48	42.041667	1072	1009	226
49	42.083333	1073	1010	229
50	42.125000	1074	1011	232
51	42.166667	1075	1012	235
52	42.208333	1076	1013	238
53	42.250000	1077	1014	241
54	42.291667	1078	1015	244
55	42.333333	1079	1016	247
56	42.375000	1080	1017	251
57	42.416667	1081	1018	254
58	42.458333	1082	1019	257
59	42.500000	1083	1020	259
60	42.541667	1084	1021	262
61	42.583333	1085	1022	265
62	42.625000	1086	1023	268
63	42.666667	1087	1024	271

TABLE 3-4 (cont'd)

CHANNEL NO	CRYSTAL FREQUENCIES (MC)	RECEIVER FREQUENCY (MC)	TRANSMITTER FREQUENCY (MC)	MICROMETER CAVITY HEAD SETTING (MILS)
64	47.958333	1088	1151	274
65	48.000000	1089	1152	277
66	48.041667	1090	1153	279
67	48.083333	1091	1154	282
68	48.125000	1092	1155	285
69	48.166667	1093	1156	288
70	48.208333	1094	1157	291
71	48.250000	1095	1158	294
72	48.291667	1096	1159	296
73	48.333333	1097	1160	299
74	48.375000	1098	1161	302
75	48.416667	1099	1162	305
76	48.458333	1100	1163	307
77	48.500000	1101	1164	310
78	48.541667	1102	1165	312
79	48.583333	1103	1166	315
80	48.625000	1104	1167	318
81	49.666667	1105	1168	320
82	48.708333	1106	1169	323
83	48.750000	1107	1170	325
84	48.791667	1108	1171	328

TABLE 3-4 (cont'd)

CHANNEL NO.	CRYSTAL FREQUENCIES (MC)	RECEIVER FREQUENCY (MC)	TRANSMITTER FREQUENCY (MC)	MICROMETER CAVITY HEAD SETTING (MILS)
85	48.833333	1109	1172	331
86	48.875000	1110	1173	333
87	48.916667	1111	1174	336
88	48.958333	1112	1175	338
89	49.000000	1113	1176	341
90	49.041667	1114	1177	343
91	49.083333	1115	1178	346
92	49.125000	1116	1179	349
93	49.166667	1117	1180	351
94	49.208333	1118	1181	354
95	49.250000	1119	1182	356
96	49.291667	1120	1183	359
97	49.333333	1121	1184	361
98	49.375000	1122	1185	364
99	49.416667	1123	1186	367
100	49.459333	1124	1187	369
101	49.500000	1125	1188	372
102	49.541667	1126	1189	374
103	49.583333	1127	1190	377
104	49.625000	1128	1191	379
105	49.666667	1129	1192	382

TABLE 3-4 (cont'd)

CHANNEL NO.	CRYSTAL FREQUENCIES (MC)	RECEIVER FREQUENCY (MC)	TRANSMITTER FREQUENCY (MC)	MICROMETER CAVITY HEAD SETTING (MILS)
106	49.708333	1130	1193	385
107	49.750000	1131	1194	387
108	49.791667	1132	1195	390
109	49.833333	1133	1196	392
110	49.875000	1134	1197	395
111	49.916667	1135	1198	397
112	49.958333	1136	1199	400
113	50.000000	1137	1200	403
114	50.041666	1138	1201	405
115	50.083333	1139	1202	407
116	50.125000	1140	1203	410
117	50.166667	1141	1204	412
118	50.208333	1142	1205	415
119	50.250000	1143	1206	417
120	50.291667	1144	1207	419
121	50.333333	1145	1208	422
122	50.375000	1146	1209	424
123	50.416667	1147	1210	427
124	50.458333	1148	1211	429
125	50.500000	1149	1212	432
126	50.541667	1150	1213	435

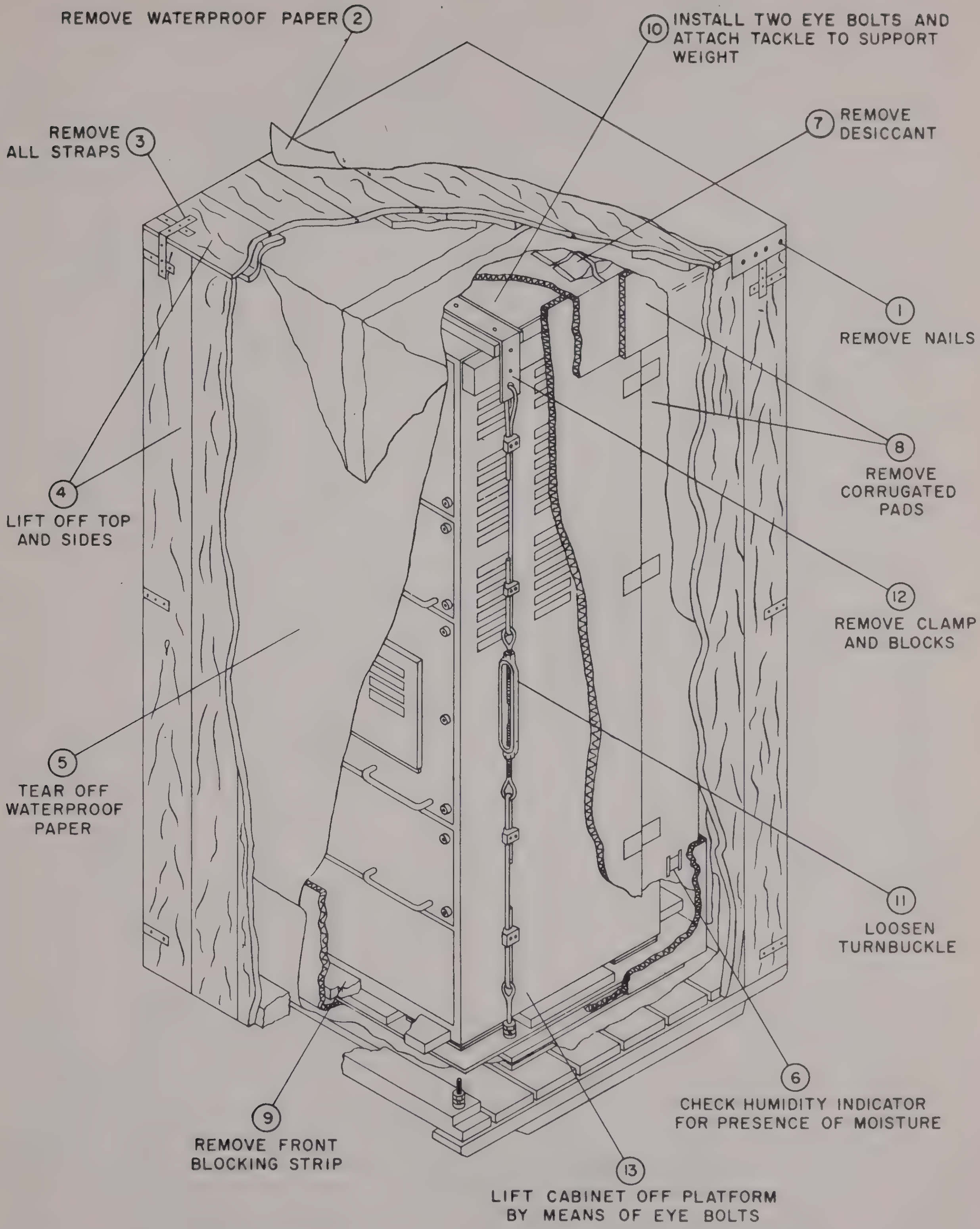
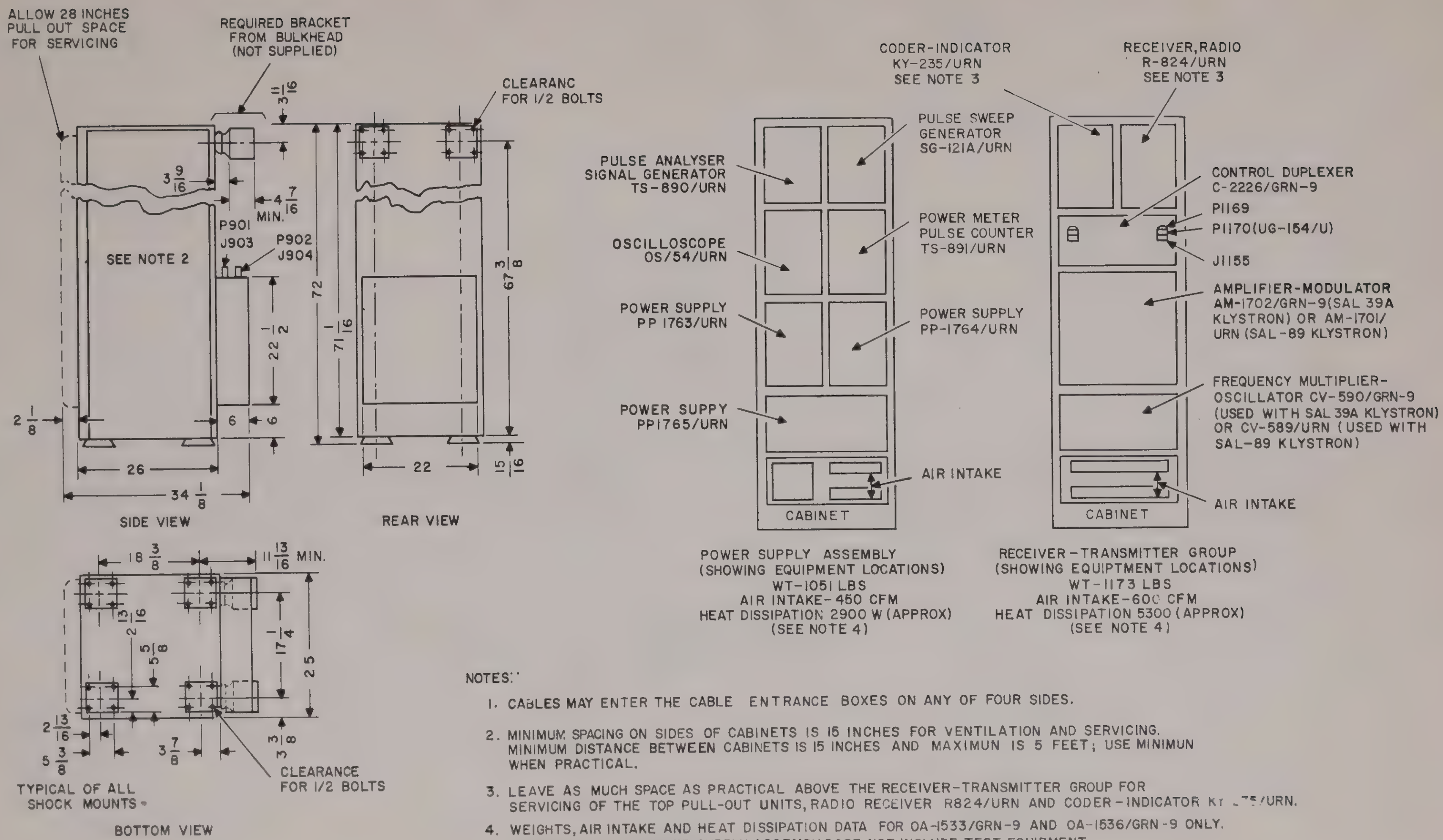


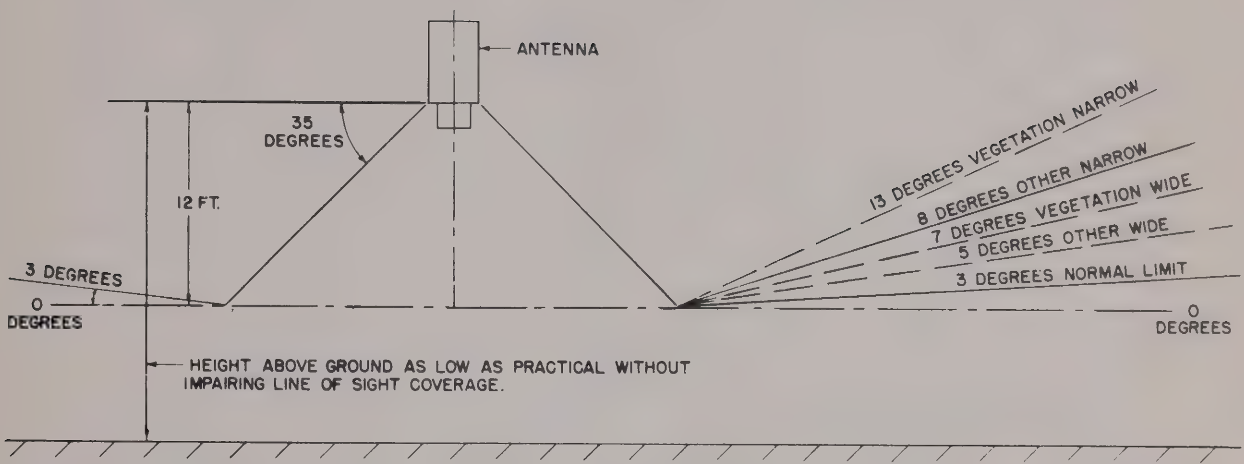
Figure 3-1. Receiver-Transmitter Group or Power Supply Assembly, Typical Unpacking Diagram



NOTES:

1. CABLES MAY ENTER THE CABLE ENTRANCE BOXES ON ANY OF FOUR SIDES.
2. MINIMUM SPACING ON SIDES OF CABINETS IS 15 INCHES FOR VENTILATION AND SERVICING. MINIMUM DISTANCE BETWEEN CABINETS IS 15 INCHES AND MAXIMUN IS 5 FEET; USE MINIMUN WHEN PRACTICAL.
3. LEAVE AS MUCH SPACE AS PRACTICAL ABOVE THE RECEIVER-TRANSMITTER GROUP FOR SERVICING OF THE TOP PULL-OUT UNITS, RADIO RECEIVER R824/URN AND CODER-INDICATOR KY-235/URN.
4. WEIGHTS, AIR INTAKE AND HEAT DISSIPATION DATA FOR OA-1533/GRN-9 AND OA-1536/GRN-9 ONLY. WEIGHT GIVEN FOR POWER SUPPLY ASSEMBY DOSE NOT INCLUDE TEST EQUIPMENT.

Figure 3-2. Receiver-Transmitter Group and Power Supply Assembly, Typical Installation Diagram



CLASS OF EXCEPTION	TYPE OF OBSTRUCTION	MAX. ANGLE SUBTENDED IN AZIMUTH	MAX. ELEVATION ANGLE (FROM POINT 12 FT. BELOW ANTENNA BASE)
CLASS (1)	VEGETATION NARROW	9 DEGREES	13 DEGREES
CLASS (1)	OTHER NARROW	3 DEGREES	8 DEGREES
CLASS (2)	VEGETATION WIDE *	30 DEGREES	7 DEGREES
CLASS (2)	OTHER WIDE *	10 DEGREES	5 DEGREES

* MAY PRODUCE SHADOWING IN SECTOR BEHIND OBSTRUCTION.

THE NUMBER OF EXCEPTIONS SHOULD NOT EXCEED 4 OR 5 CLASS 1, OR 1 OR 2 CLASS 2, OR 2 CLASS 1 PLUS 1 CLASS 2, AS ABOVE DEFINED

Figure 3-3. Location of Shore Antenna and Antenna Base

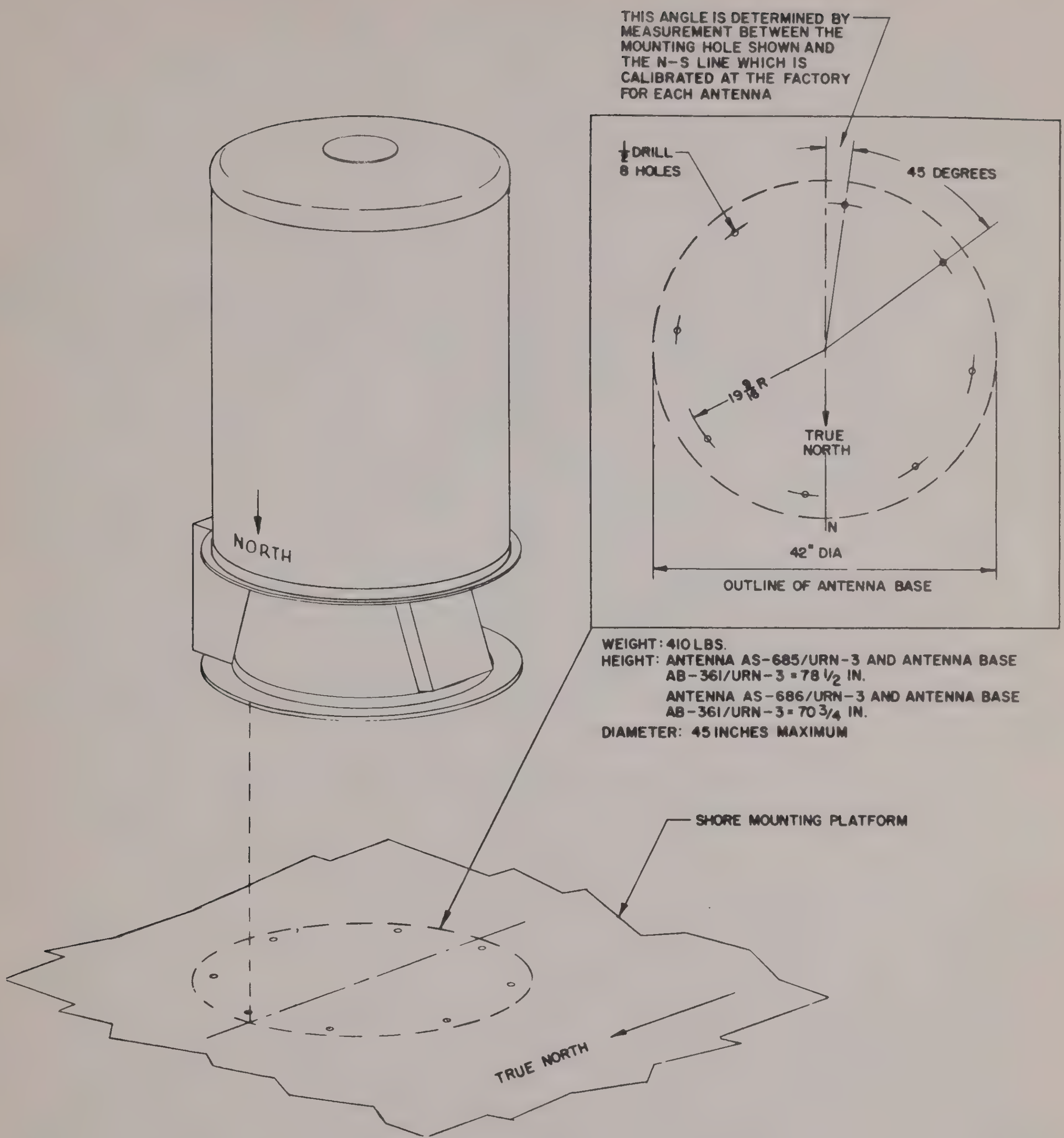


Figure 3-4. Shore Antenna With Antenna Base, Installation Diagram

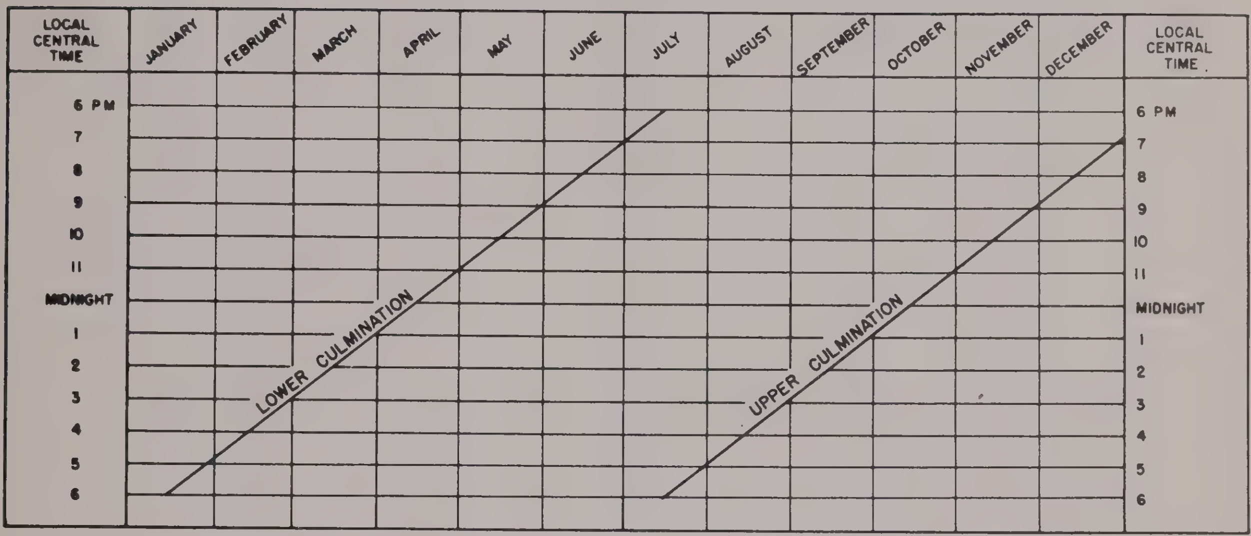


Figure 3-5. Chart for Sighting on Polaris

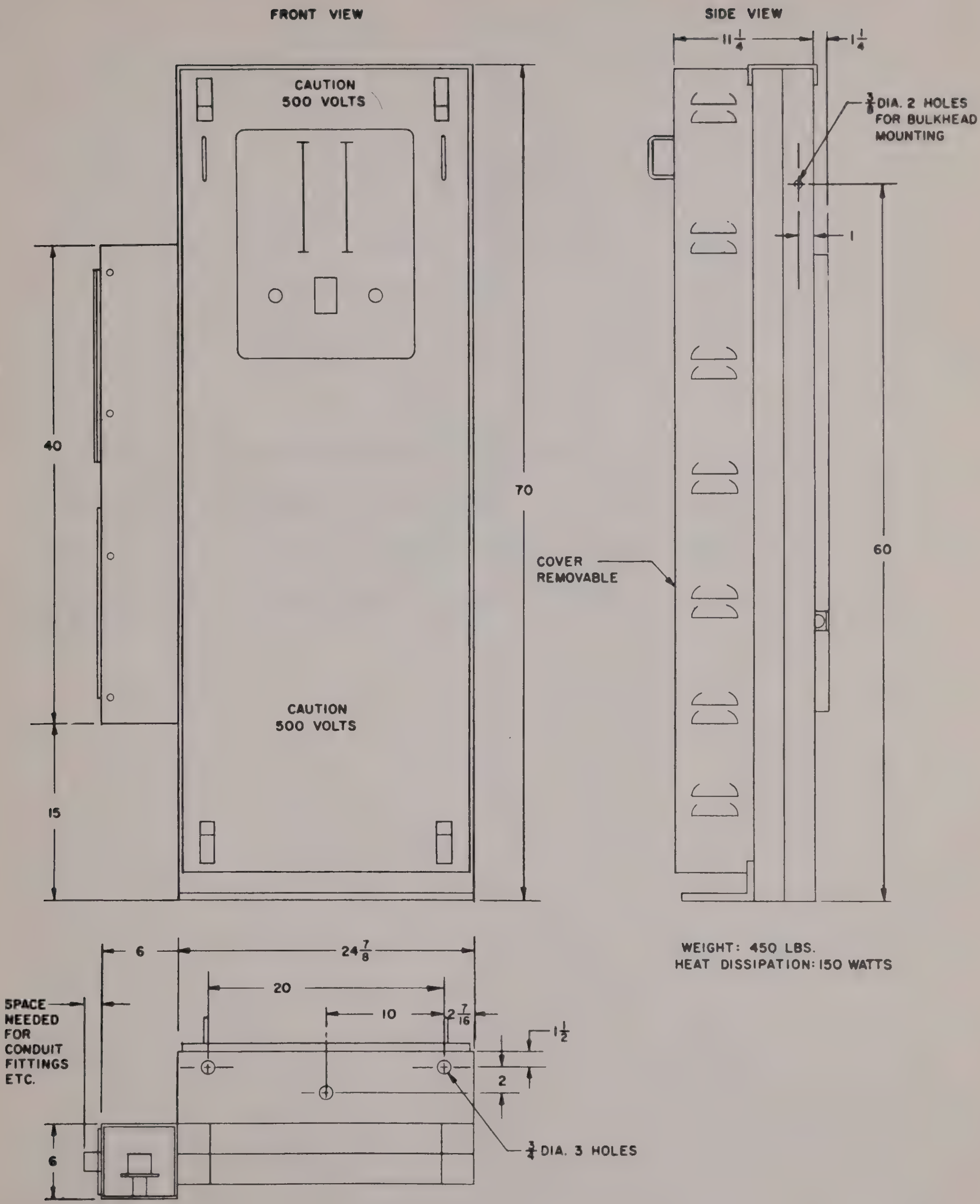


Figure 3-6. Amplifier, Antenna Control AM-1720/URN

NOTE

The illustrations listed below were not available at the time this publication was printed.

Figure 3-7. Shipboard Antenna With Antenna Base and Radome

Figure 3-8. Shipboard Antenna Control, Installation Diagram

Figure 3-9. Shore Radio Beacon, Cable Location Diagram

Figure 3-10. Shipboard Radio Beacon, Cable Location Diagram

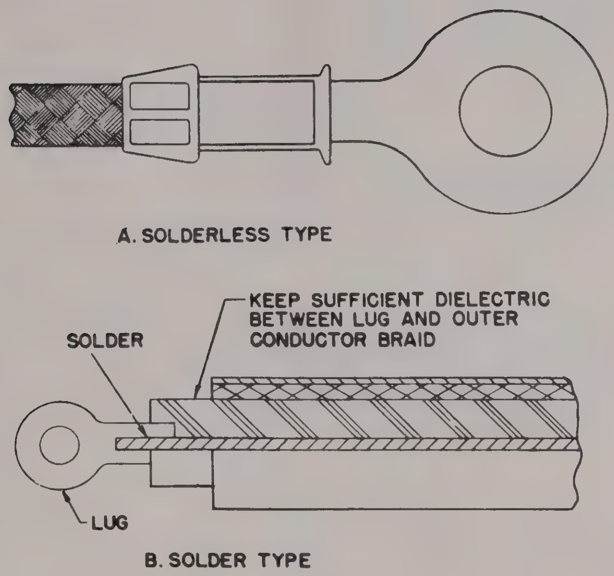
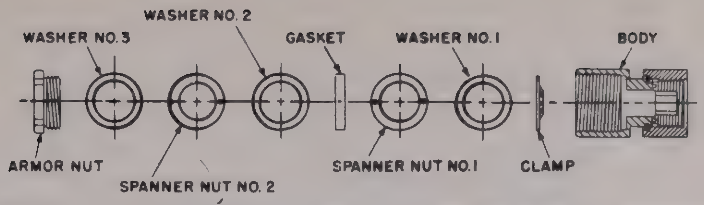
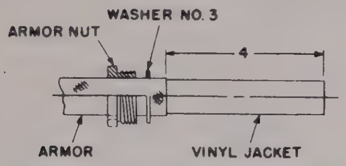
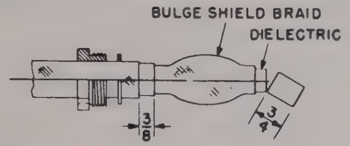


Figure 3-11. Method of Attaching Terminal Lugs

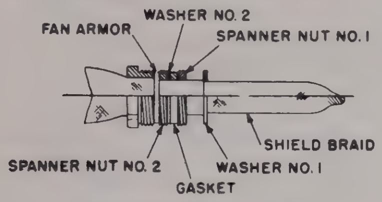




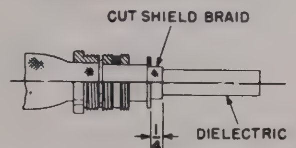
STEP 1. Slip armor nut and washer No. 3 over cable armor. Cut armor sharp and square at desired point allowing approximately 1/4 inch for fanning the armor and using connector body to determine first cut. This applies to cable which has been installed in run. Allow approximately 4 inches for making assembly. Cut off remaining cable end.



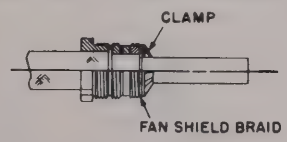
STEP 2. Cut cable jacket sharp and square with knife 3/8 inch from cut of armor. Do not damage conductor braid. Push back shield conductor braid and cut off approximately 3/4 inches of dielectric and inner conductor.



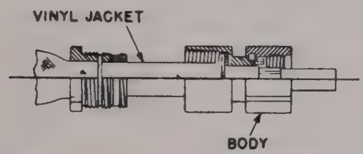
STEP 3. Pull braid forward and taper to a point. Fan 1/4 inches of armor against washer No. 3 and trim flush with washer. Slide spanner nut No. 2, washer No. 2, gasket, and spanner nut No. 1 against fanned out armor, pushing armor back to allow parts to slide over jacket. Slide washer No. 1 over braid and against jacket.



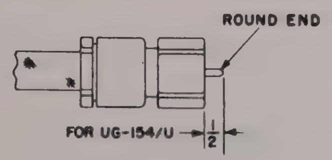
STEP 4. Cut off braid 1/4 inch from washer and fan against washer. Trim flush with outside diameter of washer.



STEP 5. Slide clamp against fanned out braid. Splitfingers on clamp should extend towards end of cable.



STEP 6. Push spanner nut No. 1 back to bulging armor, allowing approximately 2 inches for spanner wrench. Insert prepared end of cable into plug body.

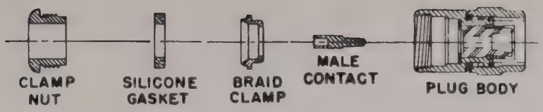


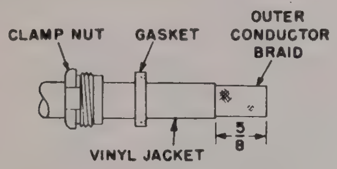
STEP 7. Apply a small amount of dielectric compound to spanner nut threads and gasket. Screw spanner nut No. 1 tightly into Body using wrench TL-323/U. Slide gasket and washer No. 2 into body. Screw spanner No. 2 tight against washer No. 2. Push armor and washer No. 3 into body by smoothing bulge in armor. Screw up armor nut tightly securing armor. Tap end of dielectric with hammer to allow braid and armor to set properly. Cut dielectric of cable flush with forward edge of coupling ring. Do not nick center conductor. Remove dielectric with gas pliers. Cut center conductor 1/2 inch from dielectric. Round off center conductor with file.

CAUTION

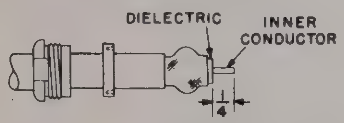
Make sure no filings are left on dielectric.

Figure 3-12. Attaching UG-1041A/U Plug to RG 18/U Cable, Assembly Details

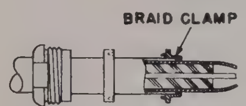




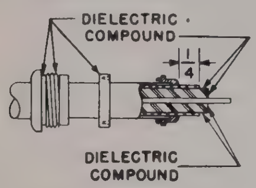
STEP 1. Cut cable to desired length. If cable is armored, push back armor approximately 2 inches and slide clamp nut and gasket over jacket. Be careful not to damage silicone gasket as it does not have the abrasive or elastic qualities of neoprene. Cut vinyl jacket sharply and squarely with knife allowing approximately 5/8 inch for making assembly. Do not damage outer conductor braid.



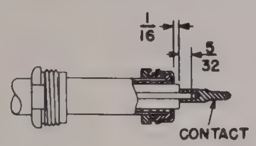
STEP 2. Push back outer conductor braid. Cut and remove approximately 1/4 inch of dielectric. Do not nick, bend, or otherwise damage inner conductor.



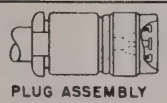
STEP 3. Pull braid forward and taper to a point. Slide braid clamp over braid and against jacket so that jacket fits snugly against internal shoulder of clamp.



STEP 4. Cut off braid 1/4 inch from braid clamp. Do not damage dielectric.



STEP 5. Unbraid ends of outer conductor and fan straight back onto tapered portion of clamp. Trim braid flush with flange portion of braid clamp so that no strands extend beyond outside diameter of flange. Braid strands should not cross each other. Cut off dielectric surface and square 1/16 inch from point where braid bends back over clamp. This dimension is critical. Be careful not to nick, bend, or otherwise damage the inner conductor. Cut off inner conductor 5/32 inch from end of dielectric.



STEP 6. Check to make sure contact fits over inner conductor and snugly against dielectric. Tin inner conductor with soft solder. Slide center contact over end of inner conductor and soft solder in place. Remove all excess solder and flux. Make certain contact is square and at right angles with dielectric. Apply a small amount of dielectric compound to end of dielectric, silicone gasket, and clamping nut threads. Push body over end of cable so that contact fits through center hole of insulator bead. Push body onto cable as far as it will go and tighten clamp nut. After assembly is complete, check contact pin to make sure that it is properly located.

Figure 3-13. Attaching UG-943A/U Plug to RG-10/U Cable, Assembly Details

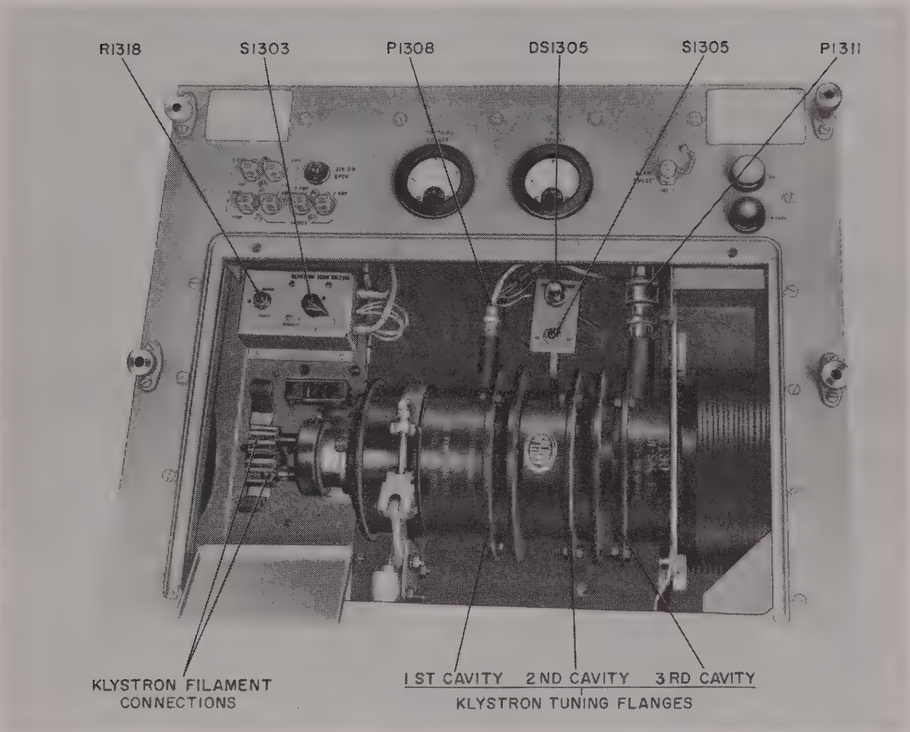


Figure 3-14. Amplifier-Modulator AM-1702/GRN-9, Front View With Klystron Access Door Open

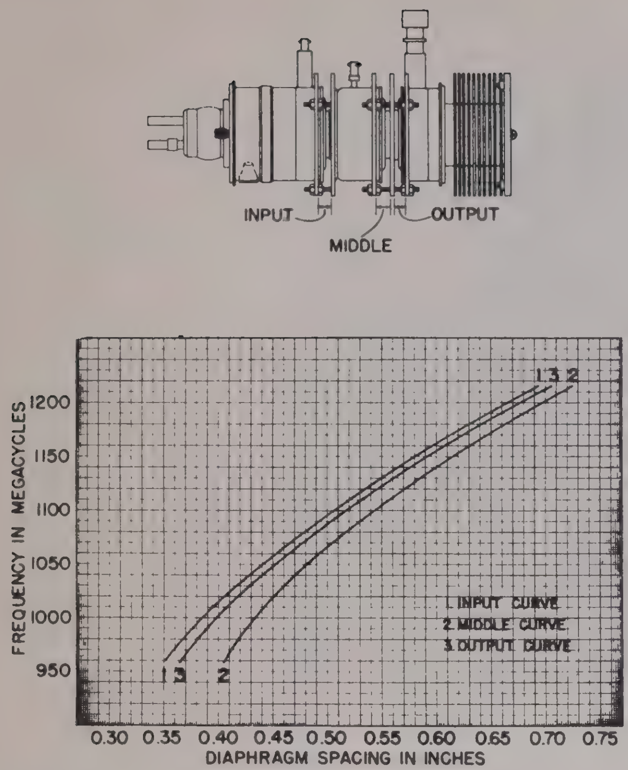


FIGURE 3-15. KLYSTRON CHARACTERISTICS-SAMPLE CALIBRATION CHART

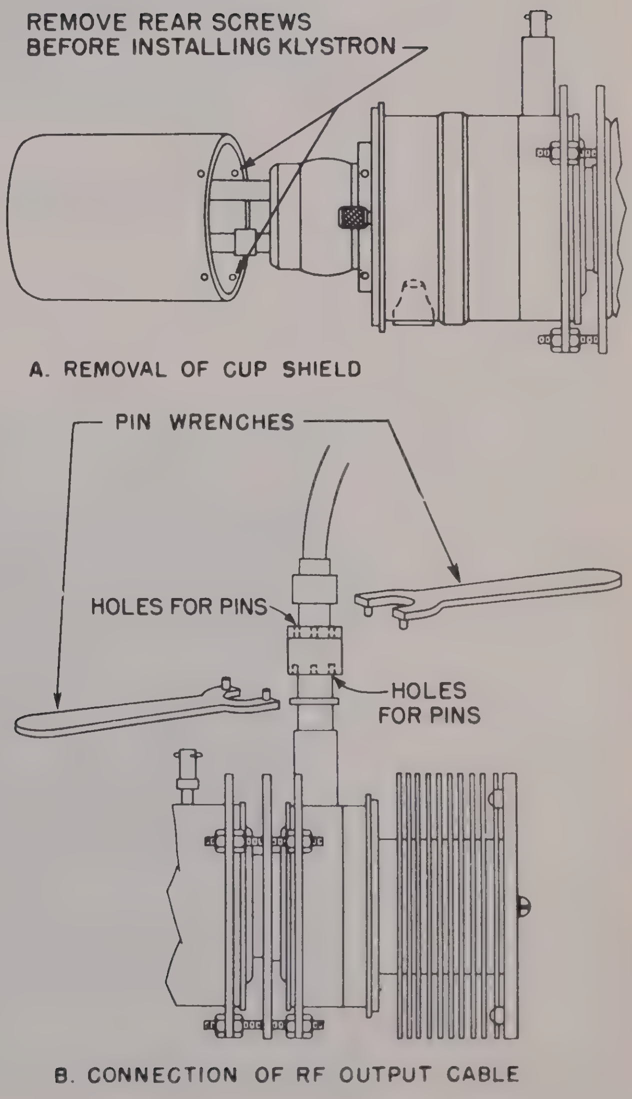


FIGURE 3-16. Klystron Installation Details

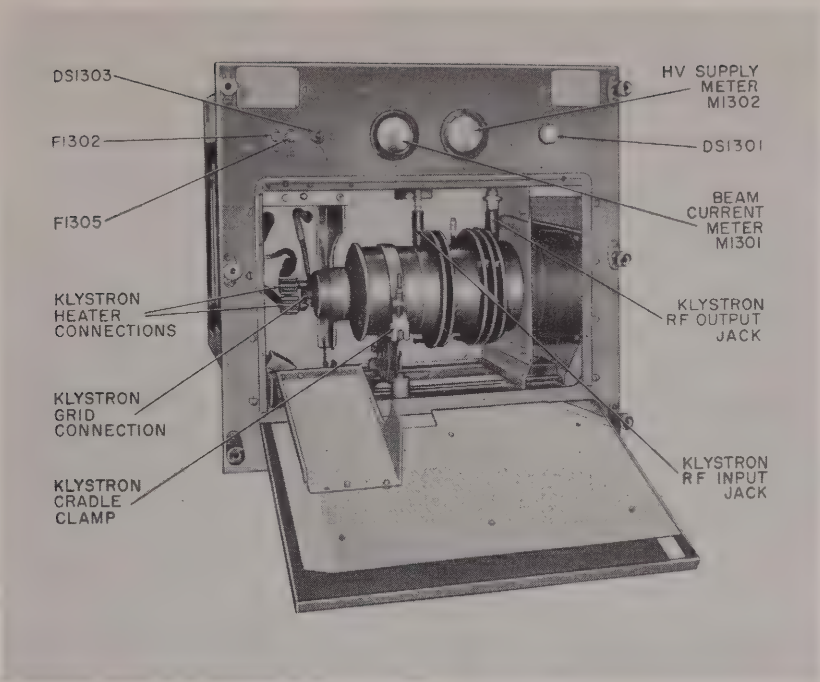


Figure 3-17. Amplifier-Modulator AM-1701/URN, Front View With Klystron Access Door Open

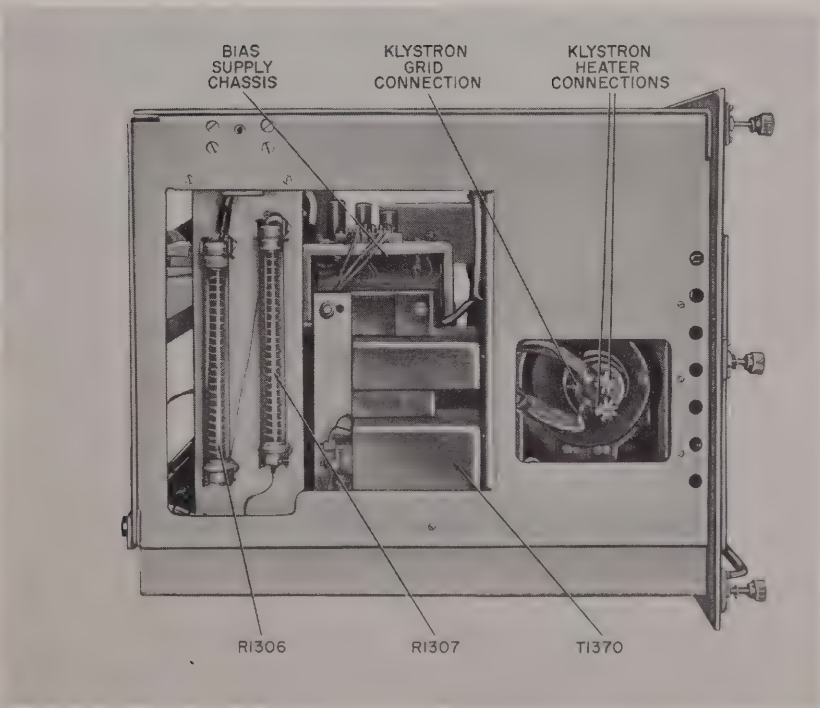
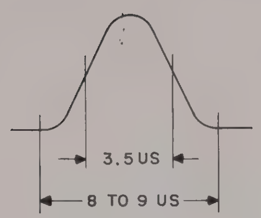
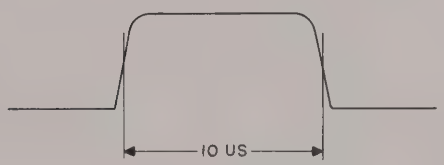


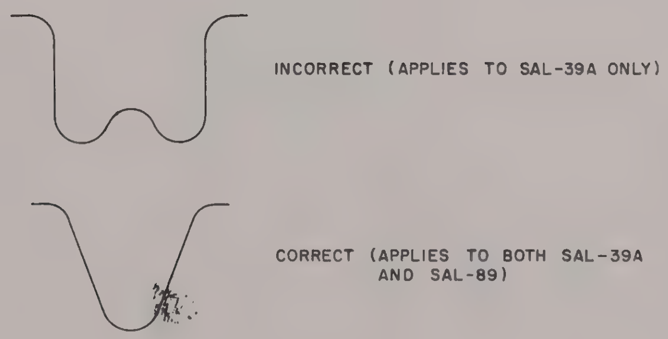
Figure 3-18. Amplifier-Modulator AM-1701/URN, Left Side View



a. WAVEFORM OBTAINED AT KLYSTRON INPUT INCIDENT JACK J1409 ON RADIO SET AN/GRN-9



b. WAVEFORM OBTAINED AT KLYSTRON INPUT INCIDENT JACK J1409 ON RADIO SETS AN/GRN-9A & AN/SRN-6



c. WAVEFORM OBTAINED AT KLYSTRON OUTPUT INCIDENT JACK J1157

Figure 3-19. Klystron Tuning Waveshapes

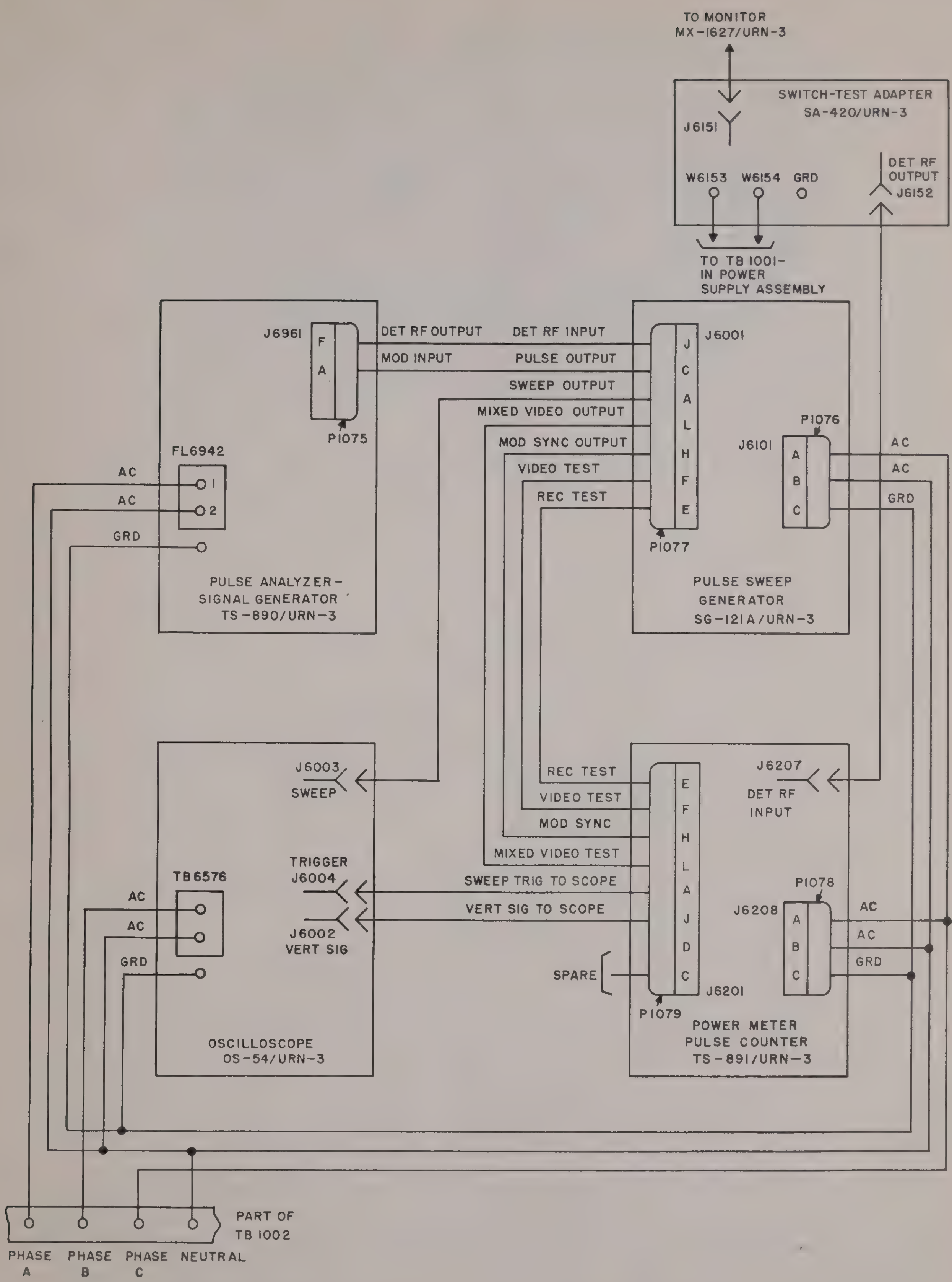


Figure 3-20. Built-In Test Equipment Interconnection Harness, Schematic Diagram

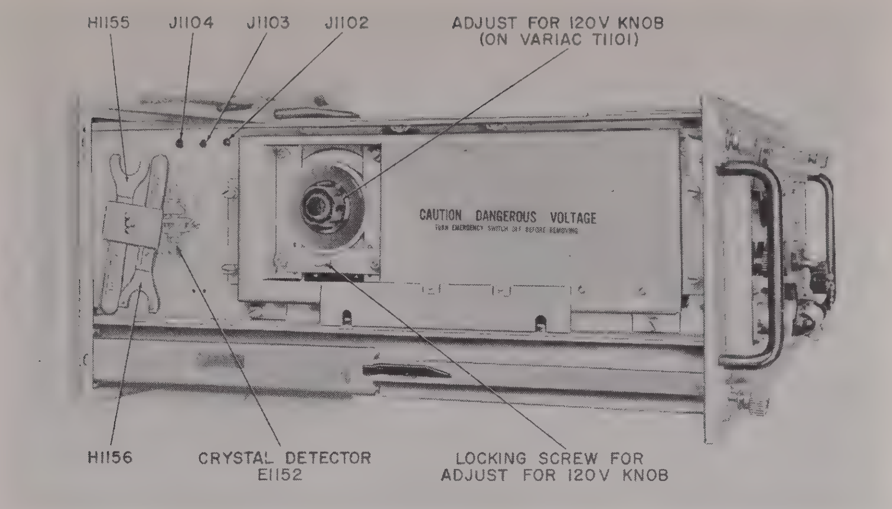


Figure 3-21. Control-Duplexer C-2225/SRN-6 or C-2226/GRN-9, Left Side View

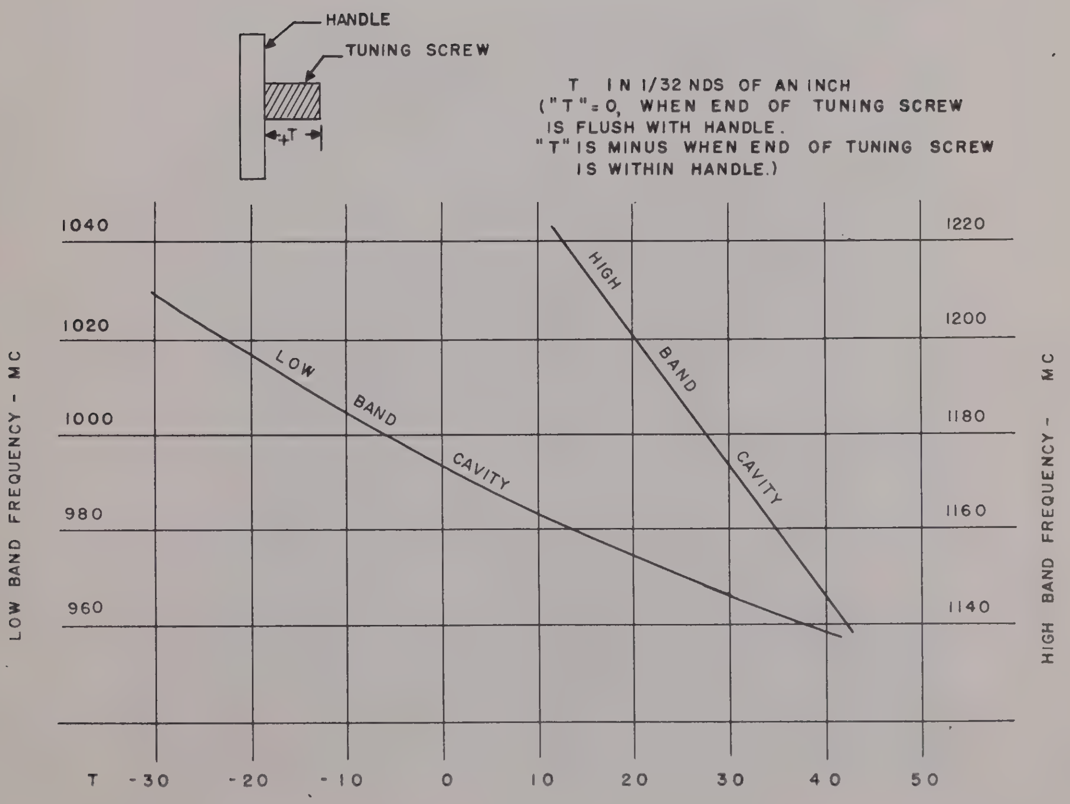


Figure 3-22. Transmission Line Filter Cavities, Tuning Curves

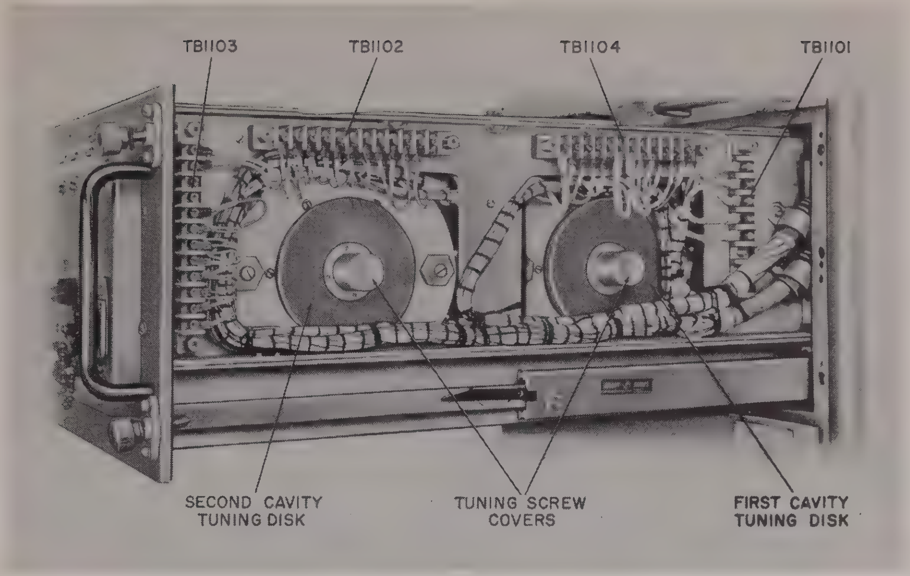


Figure 3-23. Control-Duplexer C-2225/SRN-6 or C2226/GRN-9, Right Side View

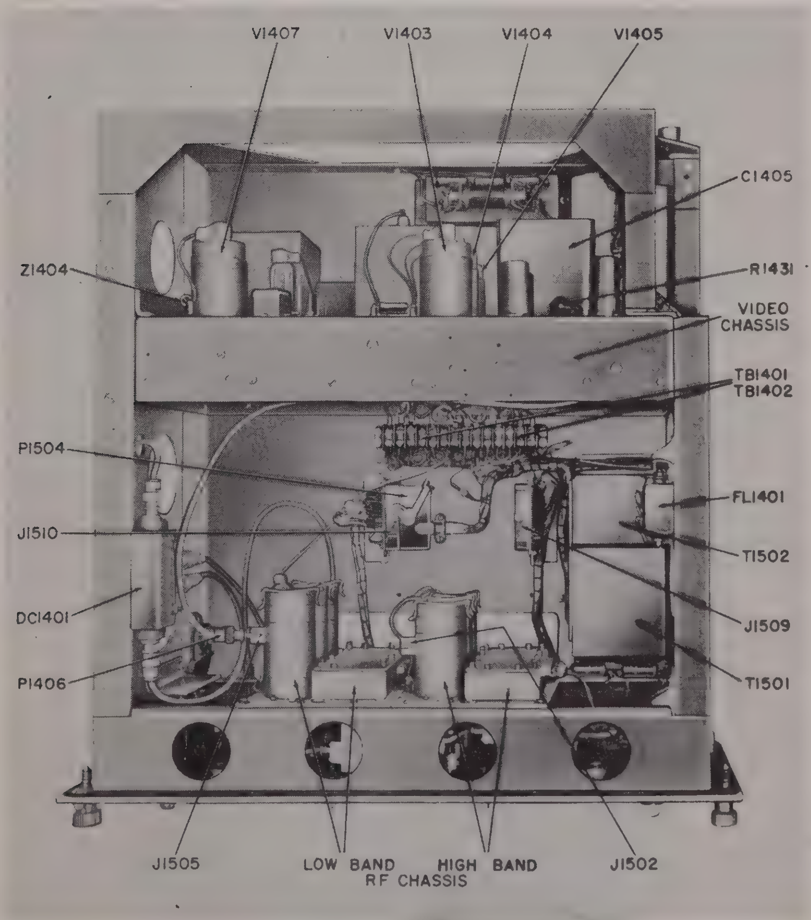


Figure 3-24. Frequency Multiplier-Oscillator CV-590/GRN-9, Top View

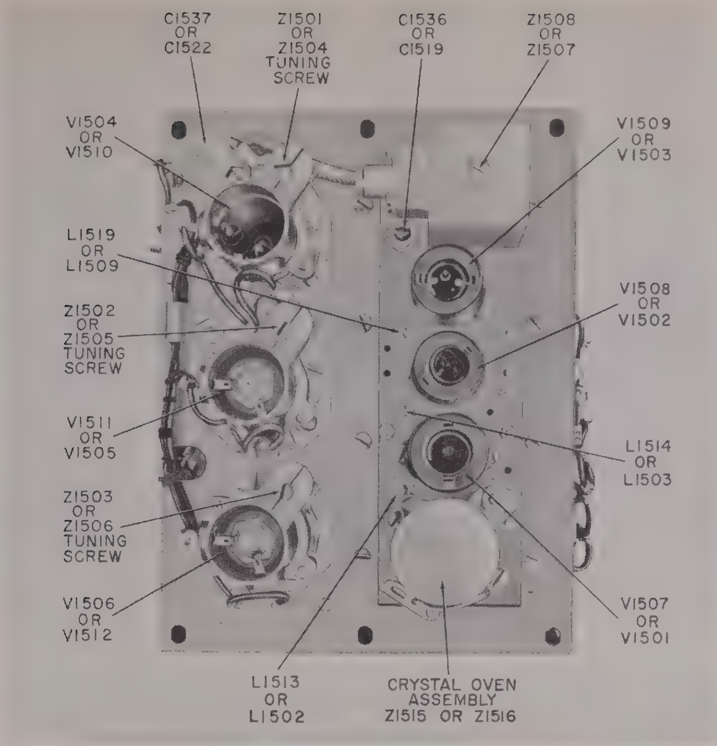


Figure 3-25. Frequency Multiplier-Oscillator CV-590/GRN-9, or CV-589/URN, R-f Chassis Top View

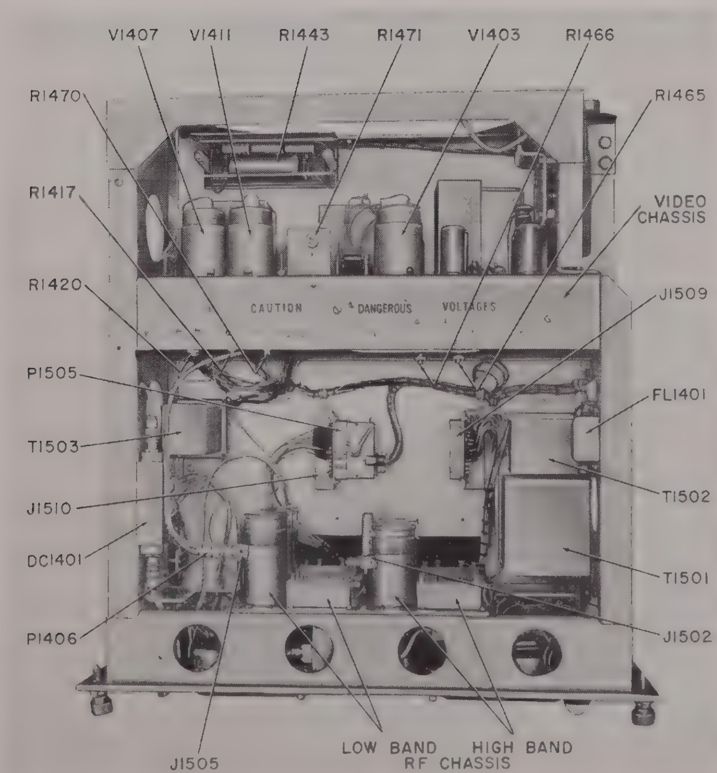


Figure 3-26. Frequency Multiplier-Oscillator CV-589/URN, Top View

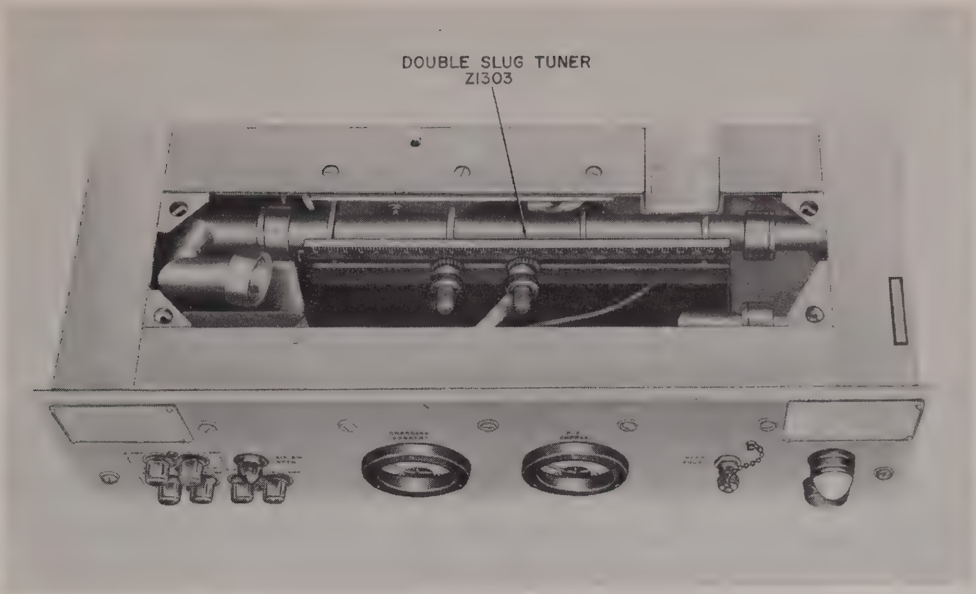


Figure 3-27. Amplifier-Modulator AM-1701/URN or AM-1702/GRN-9, Top Front View Showing Double-Slug Tuner

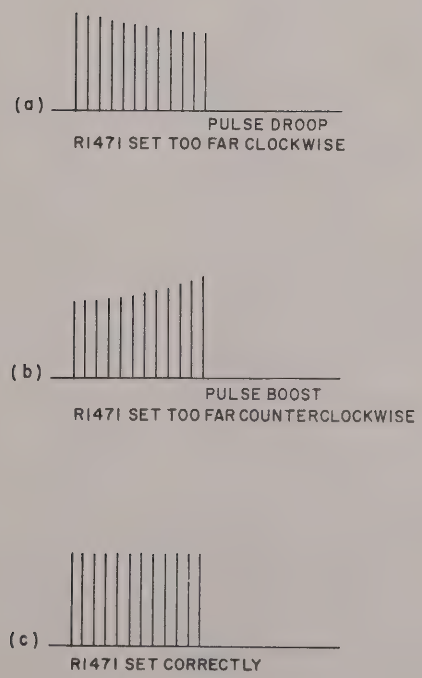


Figure 3-28. Frequency Multiplier-Oscillator CV-589/URN, Adjustment of R1471 To Correct For Pulse Drop In Reference Bursts

SECTION 4

OPERATION

1. INTRODUCTION.

Radio beacons installed at shore stations employ Radio Set AN/GRN-9 or AN/GRN-9A, and the associated antenna groups and accessories. Shipboard installations employ Radio Set AN/SRN-6 and associated equipment. Each beacon installation consists of three basic groups: namely, a receiver-transmitter group, a power supply assembly, and an antenna group. The major units of each of the three types of radio beacons are identified in table 1-1 and shown in figure 1-1.

The signals transmitted by these beacons provide aircraft equipped with Radio Set AN/ARN-21 with the distance and bearing information needed to determine their positions. Unless otherwise stated, the following information applies to all three types of beacons.

Distance information is requested by the transmitter in the aircraft by sending out interrogation signals with a repetition pattern peculiar to the aircraft's AN/ARN-21 transmitter. Reception of these distance interrogations at the radio beacon causes the transmission of a series of "replies" having the same pattern. The aircraft receives these replies along with other replies emitted by the beacon in response to interrogations from other aircraft. The AN/ARN-21 then picks out its own reply by comparing the reply pulse patterns with that of its own transmitter. Distance is determined by measuring the total time elapsed between the initial transmission of the distance interrogation pulse-pair and receipt of the corresponding radio beacon reply pulse-pair, and translating this time into miles.

Bearing information is transmitted from the radio beacon by rotating a lobed antenna radiation pattern through 360°, and then transmitting omnidirectional bursts of reference pulse-pairs at the instant that the antenna radiation pattern is in certain reference positions. The aircraft obtains its bearing from this by noting the position of the antenna pattern, as determined by the relative signal strength, at the time of the reference burst. More

detailed descriptions of the operation of the radio beacon are given in Sections 1 and 2.

2. CAPABILITIES AND LIMITATIONS.

a. RADIO BEACON. - The radio beacon transmits on one of 126 channel frequencies, one megacycle apart, in the ranges between 962 mc and 1, 024 mc and between 1, 151 mc and 1, 213 mc. It receives on one of 126 channel frequencies, one megacycle apart, in the ranges between 1, 025 mc and 1, 150 mc.

The radio beacon can provide individual distance-measuring service to 100 interrogating aircraft simultaneously. The repetition frequency of the average distance interrogation pulse which the radio beacon receives is 24 cps, from up to 95 interrogating aircraft. When receiving from 100 aircraft simultaneously, the radio beacon is operating at full load. The number of pulse-pairs that the beacon transmits per second is 3, 600. Of these, 2, 700 are either random-noise pulses, or replies to distance interrogations, and the remaining 900 are the reference burst pulses used to provide bearing information. Once every 37.5 seconds the interrogation-reply and random-noise pulses are interrupted for the transmission of identification-tone pulses.

Peak power emitted from Radio Set AN/GRN-9, which employs the SAL-39A klystron, is 5 kilowatts. Radio Sets AN/GRN-9A and AN/SRN-6, which employ the SAL-89 klystron, have a peak power output of 7.5 kilowatts. Maximum range of the radio beacon is 200 miles for distance information. Bearing information may be received beyond 200 miles depending on the altitude of the aircraft. Aircraft flying in the cone of silence, approximately 55° in any direction from the vertical extension of the antenna axis, will receive distance replies, but no bearing information.

The 126 pairs of frequencies to which the radio beacon can be tuned fall into two groups of 63 pairs each. Since one of these groups requires a high-band antenna, and the other a low-band antenna, operation of any given beacon is limited to one group of 63 channels.

b. RADIO RECEIVER R-824/URN.

(1) Radio Receiver R-824/URN (figure 4-3) receives and decodes pulse-pairs in the frequency range of 1, 025 to 1, 087 megacycles when the low-band antenna is used, and 1, 088 to 1, 150 megacycles when the high-band antenna is used.

(2) It suppresses echo produced in areas where large reflecting objects are present.

(3) It effects adjacent and near-adjacent channel rejection.

(4) It supplies an output consisting of 2, 700 ±90 pulses per second. If the interrogation rate drops below this figure, the radio receiver adds a sufficient number of random noise pulses to maintain the output pulse count. If the interrogation rate rises above 2, 700 ±90 pulses per second, the receiver rejects the weakest interrogation signals to maintain the correct output pulse count.

(5) It maintains a minimum time spacing of 65 microseconds between the pulses sent to Coder-Indicator KY-235/URN.

c. CODER-INDICATOR KY-235/URN.

Note

Throughout this book, the two types of pulses generated by the reference pulse generator will be referred to as the 15-cps reference trigger pulses and the 135-cps reference trigger pulses. Similarly, the bursts which are generated by the coder-indicator will be referred to as the 15-cps reference bursts and the 135-cps reference bursts. It is to be noted, however, that the jacks on the antenna bases and in the receiver-transmitter groups, for both ship and shore installations, are marked NORTH for the 15-cps reference trigger pulse and AUXILIARY for the 135-cps reference trigger pulse.

(1) Coder-Indicator KY-235/URN (figure 4-4) receives distance information and noise pulses from the radio receiver at the rate of 2, 700 pulses per second. Each second, it also receives 15 north reference trigger pulses (one for every 360° of antenna rotation) and 120 auxiliary reference trigger pulses (one for every 40° of rotation except for the 360° position-1/ 135th second apart) from the reference pulse-generator in the antenna. Each of the 15 reference trigger pulses received causes the coder-indicator to generate a north reference burst consisting of 12 pulse-pairs spaced 30 microseconds apart, while each of the 120 (135-cps) auxiliary reference trigger pulses causes the coder-indicator to generate an auxiliary reference

burst consisting of six pulse-pairs spaced 24 microseconds apart. These reference bursts supplement the 2, 700 ±90 pulses per second received from the receiver, so that after generation of one pulse-pair for each received pulse, plus a total of 900 additional pulse-pairs for the reference bursts, the coder-indicator puts out a total of 3, 600 ±90 pulse-pairs per second. The coder-indicator output is fed to the frequency multiplier-oscillator of the transmitter, where it initiates a signal chain which eventually causes the transmission from the radio beacon of one pulse-pair of r-f energy for each pulse-pair of coder-indicator output.

(2) The coder-indicator also generates an identification call at a 1, 350-cps double-pulse rate which is applied in International Morse code to the frequency multiplier-oscillator. When the identification keyer is down, the 2, 700 randomly spaced pulses furnished by the receiver are replaced by pulses at a 1, 350-cps repetition rate, and during this time replies to distance interrogations are not furnished.

(3) A time delay is applied to distance interrogations received so that the overall delay, from the moment that a distance interrogation is received at the antenna to the moment that a reply is transmitted from the antenna, is 50 microseconds ±0. 4 microsecond, The time delay introduced in the coder-indicator is 44 microseconds. An additional 6-microsecond delay is introduced to the signal train in the transmitter portion of the beacon to provide the overall delay of 50 microseconds.

(4) The coder-indicator houses the magnetic variation assembly that is used to orient the antenna pattern with respect to the magnetic north of any particular locality.

(5) The coder-indicator houses a tuning fork oscillator which provides a reference frequency to be used for checking the speed of rotation of the antenna.

d. TRANSMITTER. - The radio transmitter includes the frequency multiplier-oscillator (figure 4-5), the amplifier-modulator (figure 4-6), and the duplexer in the control duplexer (figure 4-2). The nomenclatures of the units comprising Radio Sets AN/GRN-9, AN/GRN-9A, and AN/SRN-6 are given in table 1-1. The transmitter functions to produce shaped r-f pulses, spaced at proper time intervals, which are radiated from the antenna. It is capable of transmitting on any one of 126 channels in the frequency ranges of 962 to 1, 024 megacycles and 1, 151 to 1, 213 megacycles. The primary

function of the duplexer is to permit simultaneous reception and transmission over a common antenna without interference. The receiver and transmitter carrier frequencies are always 63 megacycles apart.

e. CONTROL CIRCUITS.

(1) The control circuits of the radio beacon make it possible to automatically energize the units of the beacon in proper sequence so that no unit will be overloaded or damaged due to improper warmup.

(2) These circuits provide overload protection. The overload protective relays shut the system down for three seconds if an overload occurs, and then automatically re-energize it. During a continued overload, they will do this a total of three times and then will shut down the system until the cause of the overload is removed. After the cause of overload has been removed, the overload circuits must be manually reset. Other circuits put the automatic overload circuit into operation in the event of the failure of a power phase, or of a high-voltage rectifier tube.

f. ANTENNA GROUP. - Parasitic reflectors, equally spaced (every 40°) around the vertical antenna mast, shape or "modulate" the antenna radiation pattern into a modified cardioid form having a major dip and eight minor dips around its circumference. The parasitic reflector which produces the major dip is located on an inner rotating cylinder, and the other eight are on an outer rotating cylinder. Since these cylinders rotate together 15 times per second (900 rpm), the entire antenna pattern is also rotated at this rate, so that the major dip passes any given point in space 15 times per second and the minor dips pass at the rate of 135 per second.

Also contained in the antenna group is the reference pulse generator which generates a 15-cps pulse every 360° of antenna rotation and a 135-cps pulse every 40° of antenna rotation, except at zero, at which time only the 15-cps pulse is generated. These two types of pulses are used to trigger corresponding reference circuits in the coder-indicator.

The antenna cylinders are rotated by an induction motor which is maintained at constant speed by speed-control circuits included in the antenna control equipment.

A "bearing" servo system, which includes the magnetic variation subassembly located in the coder-indicator, times the pulse-pairs so that the antenna pattern is effectively oriented with respect to magnetic north.

Antennas installed on shipboard also have gyro-controlled, servo-operated stabilizers which compensate for roll and pitch to maintain the antennas in the vertical position.

3. OPERATION - GENERAL.

WARNING

OPERATION OF THIS EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES THAT ARE DANGEROUS TO LIFE. OPERATING PERSONNEL MUST OBSERVE ALL SAFETY REGULATIONS AT ALL TIMES.

a. The radio beacon is started, monitored, and stopped by controls located on the front panels of the receiver-transmitter and the power supply assembly (See figures 4-1 and 4-7.) With the exception of EMERGENCY SWITCH S901 located on the bottom panel of the receiver-transmitter group, all controls for starting the radio beacon are on the front panels of the individual units. Meters and indicating lights on the units indicate the stages completed in energizing the radio beacon, but it is not necessary for the operator to consult them during normal operation of the equipment. Because the various units of the radio beacon should be energized in proper sequence, relay circuits are provided to prevent the operator from turning on any unit prematurely.

b. The antenna control units are equipped with circuit breakers, interlocks, and switches by means of which power to the antenna spin motor, the bearing, roll, and pitch servo systems, and the speed control system may be disconnected. These components serve as a safeguard to operating personnel as well as to the equipment during service.

4. NORMAL STARTING PROCEDURE.

a. Ordinarily, when the radio beacon is functioning normally, EMERGENCY SWITCH S901 (figure 4-1) is left ON, that is, with the arrow pointing either up or down. The POWER ON-OFF switches on the various units are left in their ON positions. Power to the entire radio beacon is then under the control of the MASTER SWITCH (S1101) on the control-duplexer panel (figure 4-2). The radio beacon may be turned on, turned off, or placed in standby condition by means of this switch. The POWER ON-OFF switches for the test set components mounted in the power supply assembly are normally left in their OFF positions, and are turned ON only when the test units are to be used.

Note

When starting the radio set for the first time, or after it has been completely shut down, refer to paragraph 7 which covers the initial starting procedure.

b. To turn the radio beacon on by means of the MASTER SWITCH after the equipment has been shut off, proceed as follows: Turn MASTER SWITCH S1101 on the panel of the control-duplexer to STANDBY, and then immediately to ON. The LV-MV READY lamp (DS1605) on the panel of the low-voltage power supply will light after a one-minute delay, and the HV READY lamp (DS1902) on the panel of the high-voltage power supply will light after a five-minute delay.

c. When the MASTER SWITCH is placed in the ON position and the radio beacon is functioning normally, the following indicating lamps will light: MAIN POWER ON (DS1102), FIL ON (DS1105), and ANTENNA CONTROL ON (DS1103) on the control duplexer panel (figure 4-2), and LV MV READY (DS1605) and HV READY (DS1902) on the panels of the low-voltage and high-voltage power supplies (figures 4-10 and 4-12) respectively. The following lights should NOT be lit:

(1) On the panel of the medium-voltage power supply, OVERLOAD MV (DS1803). (See figure 4-11.)

(2) On the high-voltage power supply panel, OVERLOAD HV (DS1903).

(3) On the control-duplexer panel, INTLK SHORTED (DS1104).

Note

The BATTLE SHORT switch (S1107- see figure 4-2) should be in the NORMAL position. This switch is used in the BATTLE SHORT position only when one or more of the interlocks fail during an extreme emergency such as battle conditions. The operator should not turn the switch to the BATTLE SHORT position unless told to do so by an authorized person. Because opening the amplifier-modulator or high-voltage power supply drawer units with the BATTLE SHORT switch in the INTLK SHORTED position would cause serious damage to the equipment and endanger personnel, this switch has been

Note (Cont'd)

made ineffective for turning on high voltage while the drawer units are open.

d. The following indicating lamps should also be lit:

(1) On the radio receiver panel, POWER ON (DS501). (See figure 4-3.)

(2) On the coder-indicator panel, POWER ON (DS601) and ANTENNA CONTROL (DS602). (See figure 4-4.)

Note

If this light is blinking, trouble in the antenna system is indicated.

(3) On the frequency multiplier-oscillator panel, FILAMENT (DS1401) and OVEN (DS1403). (See figure 4-5.)

Note

The NORMAL lamp on the front panel of the frequency multiplier-oscillator will turn on and off as the oven thermostat turns on and off to maintain the correct crystal oven temperature.

(4) On the amplifier-modulator panel, FIL (DS1301), and on the amplifier-modulator panel of Radio Set AN/GRN-9 only, +700 (DS1302). (See figure 4-6.)

Note

Check that the AIR SW OPEN lamp (DS1303) is not lit.

(5) On the power supply assembly cabinet, LV (DS1603), -375 (DS1601) +700 +1000 (DS1801), and HV (DS1901). (See figure 4-7.)

Note

If the blown fuse indicators or amber lamps are on, trouble is indicated and should be reported to the technician.

5. STANDBY OPERATION.

Standby operation provides a means of keeping the radio set ready for immediate operation with no r-f signal being generated by the radio set. When the MASTER SWITCH is in the STANDBY position, all filament voltages are on and all d-c voltages are off. Since there is no direct current flowing through the vacuum tubes and voltage dividers, the amount of heat generated in the radio set, and the aging of electronic components, is reduced. After

the filament voltages have been on for five minutes, all time delays will have been completed, and the radio set may be fully energized without further delay by switching the MASTER SWITCH from STANDBY to ON.

To operate the radio set in standby condition, follow the normal starting procedure described in paragraph 4 of this section and then set the MASTER SWITCH in the STANDBY position.

6. REMOTE OPERATION.

By means of a remote control unit, it is possible to place the radio set in its off, on, or standby operating condition from a remote point. To operate the radio set from a remote position, follow the normal starting procedure described in paragraph 4 of this section, then set the MASTER SWITCH in the REMOTE position. With switch S1 on the remote control unit set at OFF, the radio set will be off and all three pilot lights on the remote unit will be extinguished. When switch S1 is set to STANDBY, filament voltages are switched on, and the white ON lamp (DS1) on the remote control unit will light. To turn the radio set on, turn switch S1 to ON. After a time delay of one minute, the red READY lamp (DS2) will light, indicating that the low-voltage and medium-voltage power supplies are ready for operation. When a five-minute time delay has elapsed after turning on the filaments, the radio set will be completely energized, and the red HV ON lamp (DS3) on the remote control unit will light.

7. INITIAL STARTING PROCEDURE.

Under certain conditions, it may be necessary for the operator to start the radio beacon after all switches have been turned off. To do this, proceed as follows:

Step 1. Turn the switches on the antenna control unit to ON.

Step 2. Check to see that all switches on the control-duplexer are turned to OFF. Turn the ANTENNA POSITION SELECTOR switch (S606) on the coder-indicator to STOW, in the case of a shore installation, or to STABILIZED in the case of a shipboard installation.

Step 3. Turn the EMERGENCY SWITCH (S901) to ON (arrow pointing up or down).

Note

When the EMERGENCY SWITCH is set to the ON position, both the OVEN and NORMAL lamps on the front panel of the

Note (Cont'd)

frequency multiplier-oscillator will light. After the oven reaches operating temperature, the NORMAL lamp will go out. Thereafter, the NORMAL lamp will go on and off as the heating element in the crystal oven goes on and off to maintain the correct oven temperature.

Step 4. Turn the MASTER SWITCH S1101 to STANDBY.

Step 5. Throw the receiver ON-OFF switch S502 on the panel of the radio receiver to ON, the coder-indicator ON-OFF switch S601 on the coder-indicator panel to ON, and ANTENNA CONTROL S1102 and FIL ON switch S1108 on the control duplexer panel to ON.

Note

All ON-OFF switches on the test equipment should be left in the OFF positions, unless the test equipment is to be used for checking the operation of the radio beacon.

Step 6. Turn the MASTER SWITCH (S1101) to ON.

Note

One minute will elapse from the time that the MASTER SWITCH is moved to STANDBY before voltage is available for the blue LV MV READY light (DS1605) on the low-voltage power supply panel. This lamp will light after this delay only if the MASTER SWITCH and the FIL ON switch (S1108) are at ON.

Step 7. After the LV MV READY light (DS1605) comes on, set the LV ON-OFF switch (S1601) to ON.

Step 8. Set the MV ON-OFF switch (S1801) to ON.

Note

Five minutes will elapse from the time that the MASTER SWITCH is turned to the STANDBY position, before voltage is available for the blue HV READY light (DS1901) on the high-voltage power supply panel. This lamp will light after the five-minute delay only if the MASTER SWITCH, the LV ON-OFF, and FIL ON switches are ON.

WARNING

OPERATION OF THIS EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES WHICH ARE DANGEROUS TO LIFE. OPERATING PERSONNEL MUST AT ALL TIMES OBSERVE ALL SAFETY REGULATIONS. DO NOT CHANGE TUBES OR MAKE ADJUSTMENTS INSIDE THE EQUIPMENT WITH THE HIGH-VOLTAGE SUPPLY ON. DO NOT DEPEND UPON SAFETY INTERLOCK SWITCHES FOR PROTECTION. UNDER CERTAIN CONDITIONS DANGEROUS POTENTIALS MAY EXIST IN THE CIRCUITS WITH POWER CONTROLS IN THE OFF POSITION DUE TO CHARGES RETAINED BY CAPACITORS. TO AVOID SHOCK AND SEVERE BURNS ALWAYS DISCHARGE AND GROUND CIRCUITS PRIOR TO TOUCHING THEM. NEVER SERVICE OR ADJUST THE EQUIPMENT WITHOUT THE PRESENCE OR THE ASSISTANCE OF ANOTHER PERSON CAPABLE OF RENDERING AID.

CAUTION

If the equipment has not been used for a period of three months, it will be necessary to age the klystron prior to the application of full beam voltage to it. (Refer to paragraph 17 of Section 3 if aging is necessary.)

Step 9. When the HV READY LAMP (DS1902) is lit, place the HV ON-OFF switch (S1901) in the ON position. The equipment is now fully energized and operating. Make sure that the red HV lamp (DS1901) is lit.

8. STOPPING THE RADIO SET.

a. Turn the MASTER SWITCH (S1101) to the OFF position.

Note

Under ordinary conditions, the EMERGENCY SWITCH at the bottom of the receiver-transmitter cabinet (see figure 4-1) is left ON, and all the ON-OFF switches except those on the TEST SET are left in their ON positions.

b. When the radio set is being shut down completely (that is, when all switches are being turned off) place the MASTER SWITCH (S1101) in the OFF

position and wait at least one minute before turning the EMERGENCY SWITCH (S901) off. This delay is necessary, since the cooling blowers will continue to run for one minute after the MASTER SWITCH has been turned off, but will stop immediately when the EMERGENCY switch is turned off. If the blowers are turned off too soon, serious damage may result to the equipment, owing to excessive temperatures.

9. FRONT PANEL CHECK TO DETERMINE IF EQUIPMENT IS FUNCTIONING NORMALLY.

a. After the equipment has been started in accordance with the procedures outlined above, the following observations should be made to determine whether the equipment is functioning properly.

Note

> These observations do not constitute a complete operational check. They are intended, rather, to give the operator reasonable assurance that the equipment is functioning normally. Refer to Section 5 for complete operator's check procedures.

Compare the readings obtained in the checks given below with those initially entered in the equipment log to make sure they are within 10 percent of logged readings.

(1) TUNING METER (M1401), located on the front panel of frequency multiplier-oscillator. (See figure 4-5.)

(2) DC SUPPLY VOLTAGE meter (M1301), located on the front panel of the amplifier-modulator. (See figure 4-5.)

(3) CHARGING CURRENT meter (M1301), located on the front panel of the amplifier-modulator. (See figure 4-6.)

(4) H. V. SUPPLY meter (M1302), located on the front panel of the amplifier-modulator. (See figure 4-6.)

(5) TEST METER (M501) located on the front panel of the receiver. (See figure 4-3.)

(a) The squitter control voltage should read within 5 percent of the initial entry.

(b) The CR201 and CR202 currents should read within 10 percent of the initial entry.

b. In the case of shipboard installations, observe the ANTENNA SERVOS meter on the front panel of the coder-indicator for each one of the four positions of the METER SELECTOR switch. Check that none of the readings is in the red portion of the meter scale.

c. For shore-based installations, check the ANTENNA SERVOS meter on the coder-indicator front panel with the METER SELECTOR switch in the SPEED position only.

d. In the case of shipboard installations check with qualified personnel to determine whether the magnetic variation for the present geographical location of the ship is the same as the correction for magnetic variation indicated by the reading of the SET TO MAGNETIC VARIATION dial. (Refer to paragraph 11 of this section for detailed information on adjustment for magnetic variation.)

10. SETTING THE CODE (IDENTIFICATION CALL).

a. It may be necessary to change the identification code. This is done in the following manner (see figures 4-8 and 4-9):

(1) Loosen the four captive screws on the panel of the coder-indicator and pull out the unit.

(2) Manually cheat the interlock.

(3) Snap the code switch S605 to OFF.

(4) Remove the nut on the code wheel by rotating it counterclockwise.

(5) Remove the code wheel by pulling it forward with the handles provided.

CAUTION

During removal or replacement of the code wheel, use care when lifting the coding switch cam to prevent damage to the switch (S607). (See figure 4-8.)

b. The code on the cam wheel is changed by loosening the screws in the segments, pulling out or pushing back the necessary cam segments, and then tightening the screws. Always set up the code starting with the cam segment marked START CODE. It is desirable to allow three segments, including the one marked START CODE, before the code is actually started. Therefore, unless the code uses more than 50 segments, the first three segments, including the one marked START CODE, should not be used, and the code should be set up starting with the fourth segment. A dot consists of a single pulled-out segment. A dash consists of three pulled-out segments. To separate dots

and dashes, one segment is pushed back between a dot and a dash, or between two dots, or between two dashes. Three segments are pushed back between characters of the code.

For example, the code "USA" is inserted in the following manner (see figure 4-9): The segment marked START CODE and the next two segments should be pushed back. The fourth segment should be pulled out. This comprises the first dot of the character U. The fifth segment should be pushed back, the sixth pulled out (second dot of character U), the seventh pushed back, and the next three segments be pulled out. This completes the character U, "dot-dot-dash". After completing the character U, three segments are pushed back, to separate the U from the following S. For the character S three alternate segments are pulled out, forming "dot-dot-dot". After this character is completed, three segments are again pushed back, to separate the S from the following A. The character A is formed by pulling out the next segment, pushing back the following one, and finally pulling out the three following segments, thereby completing the "dot-dash" of the A. The complete code, "USA", has now been installed. All other segments should be pushed back.

c. Replace the coding wheel by engaging the two locating pins on the wheel hub. Use caution during this procedure to avoid damage to the coding switch. Replace the hub nut. Tighten the hub nut securely by turning it in the clockwise direction. Manually turn switch S605 to ON. During the interval of time that the code changes are made, as outlined above, no identification is being transmitted from the radio beacon. However, bearing and distance information is not interrupted during this interval.

11. ADJUSTMENT FOR MAGNETIC VARIATION (SHIPBOARD).

a. Check the reading of the SET TO magnetic variation dial to see that the correct compensation for magnetic north has been set in. (See figure 4-4.)

Note

> Depending upon the geographical location of the ship, angular difference between magnetic north and true north must be compensated for. This is necessary, because the ship's compass is oriented with respect

Note (Cont'd)

to true north, whereas the 15-cps or north reference for aircraft is to be oriented with respect to magnetic north.

CAUTION

At shore installations, the servo motor lock must be loosened before compensation for magnetic north can be set in.

b. Rotate the dial lock of the magnetic variation subassembly counterclockwise, until the main SET TO MAGNETIC VARIATION knob rotates freely.

c. Set the required variation in degrees on the hairline of the dial. For variations west of true north, the dial should be rotated toward increasing numbers, that is, from 0° up to 10°, 20°, etc. For variations to the east of true north, the dial should be roated from 0° (360°) down, that is toward 350°, 340°, etc.

d. At shore installations only, tighten the servo motor lock.

e. Tighten the dial lock.

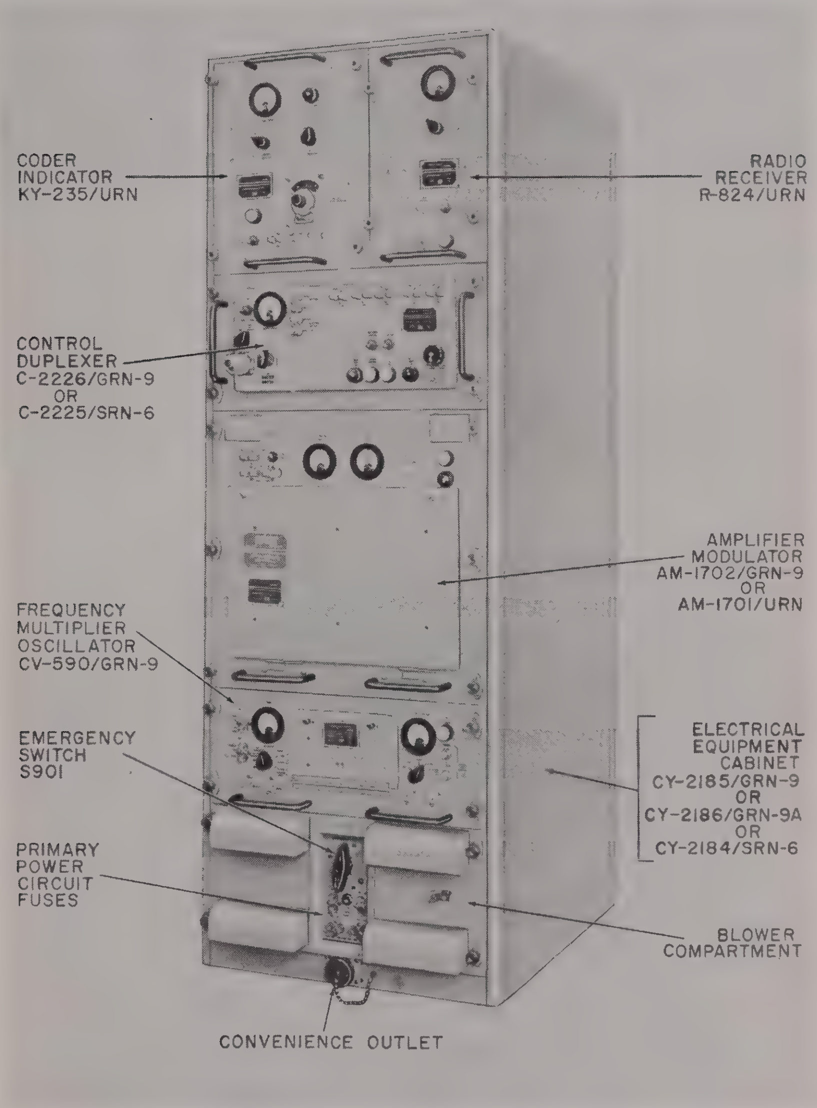


Figure 4-1. Receiver-Transmitter Group OA-1533/GRN-9, Front View

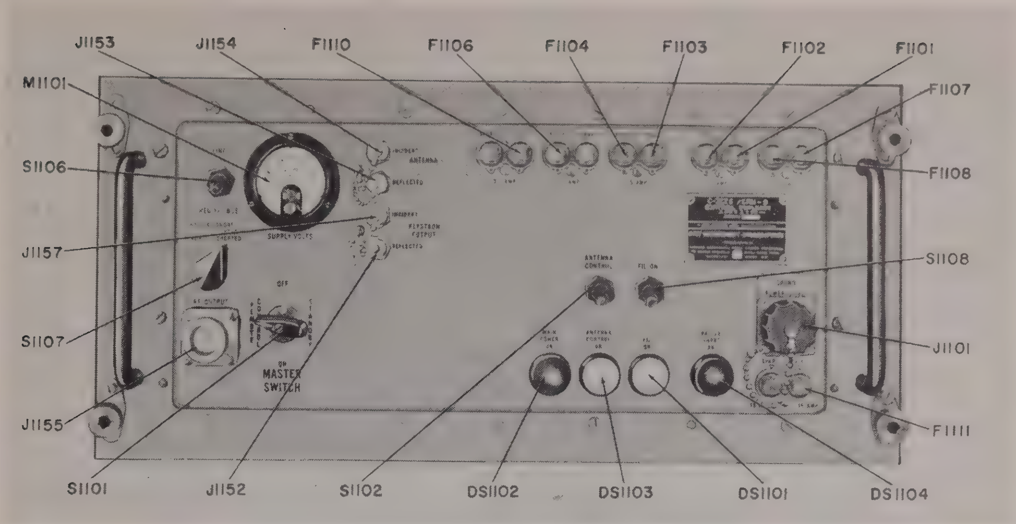


Figure 4-2. Control Duplexer CV-2226/GRN-9 or CV-2225/SRN-6, Front Panel View

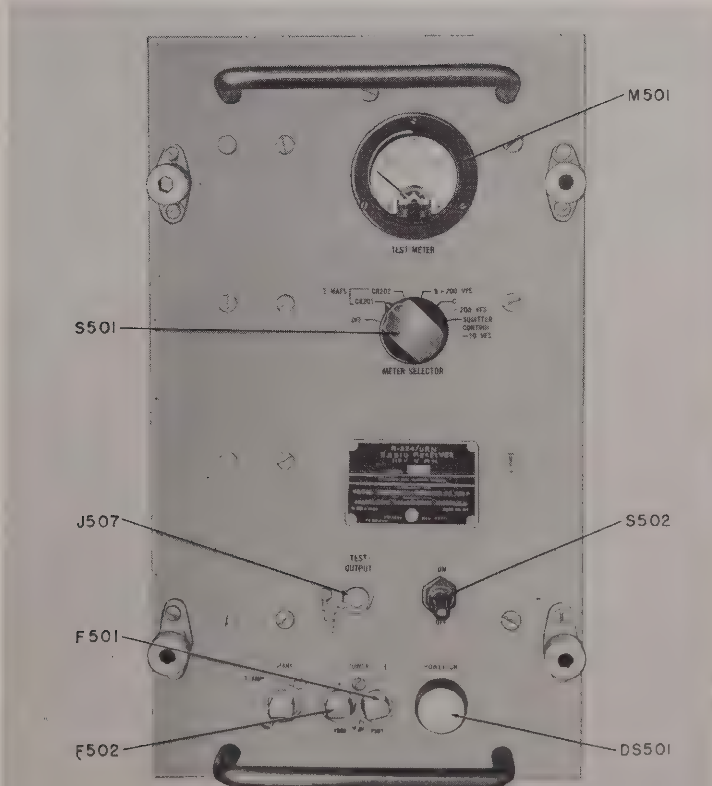


Figure 4-3. Radio Receiver R-824/URN, Front Panel View

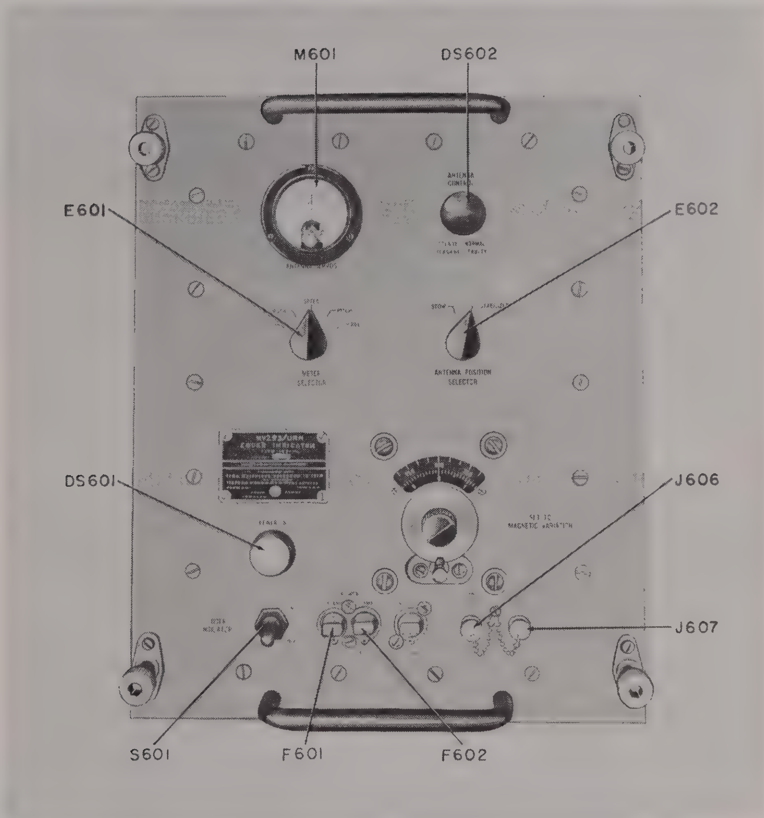


Figure 4-4. Coder-Indicator KY-235/URN, Front Panel View

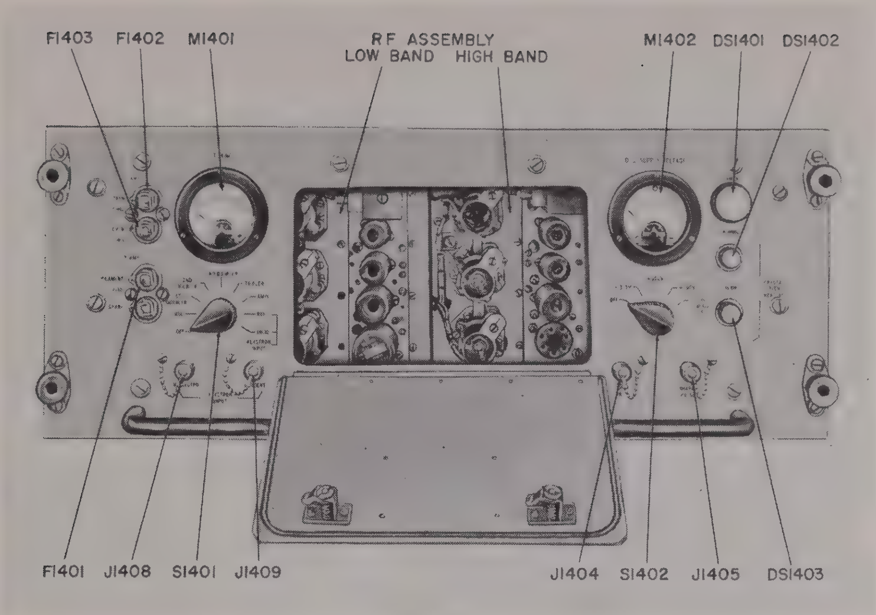


Figure 4-5. Frequency Multiplier-Oscillator CV-589/URN or CV-590/GRN-9, Front Panel View

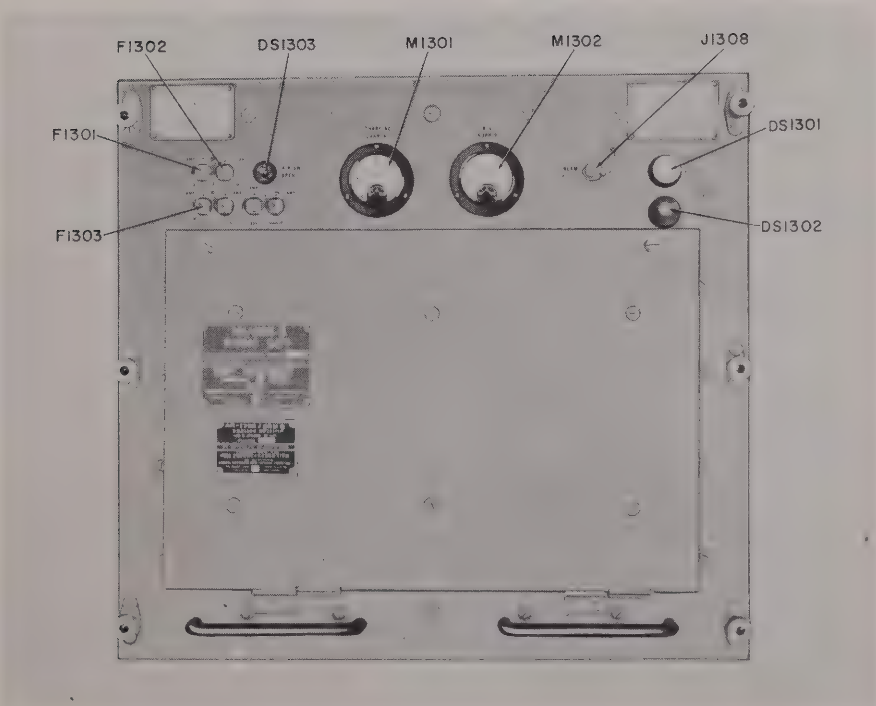


Figure 4-6. Amplifier-Modulator AM-1702/URN, Front Panel View

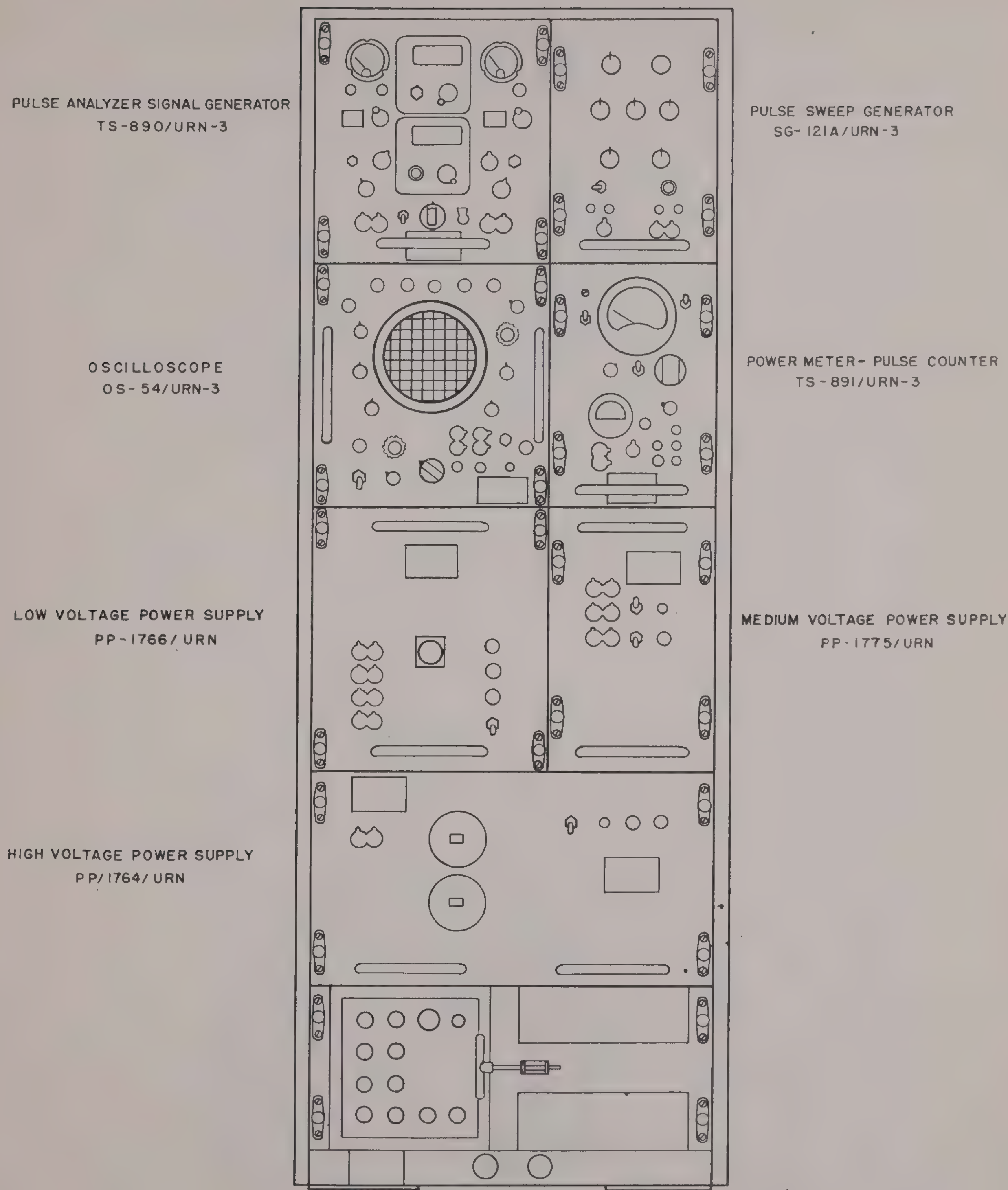


Figure 4-7. Power Supply Assembly OA-1536/GRN-9, with Test Equipment, Front Panel View

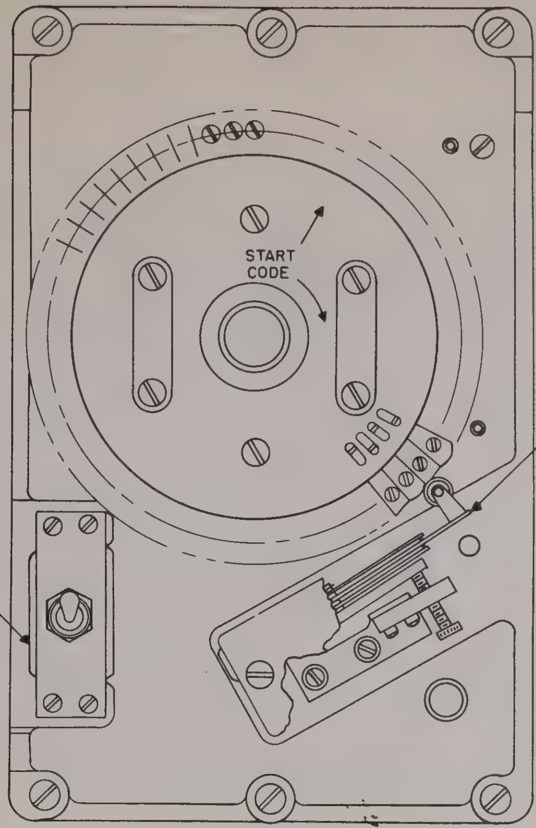


Figure 4-8. Coder-Indicator Tone Wheel Assembly

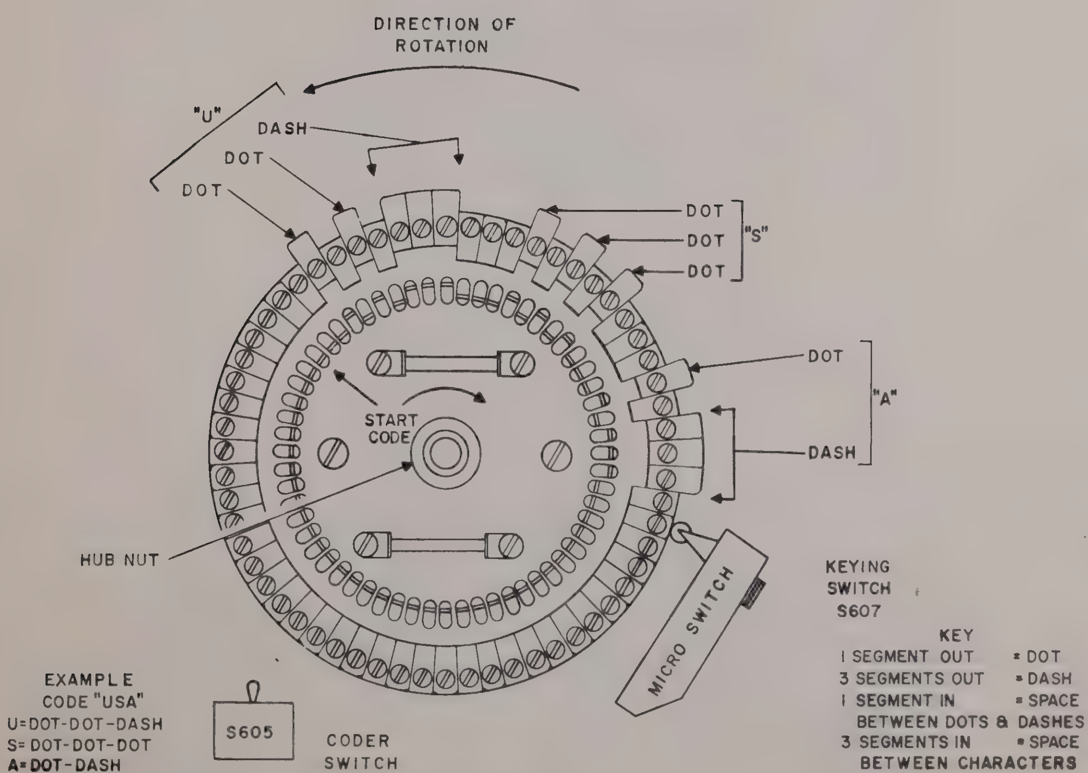


Figure 4-9. Setting the Code

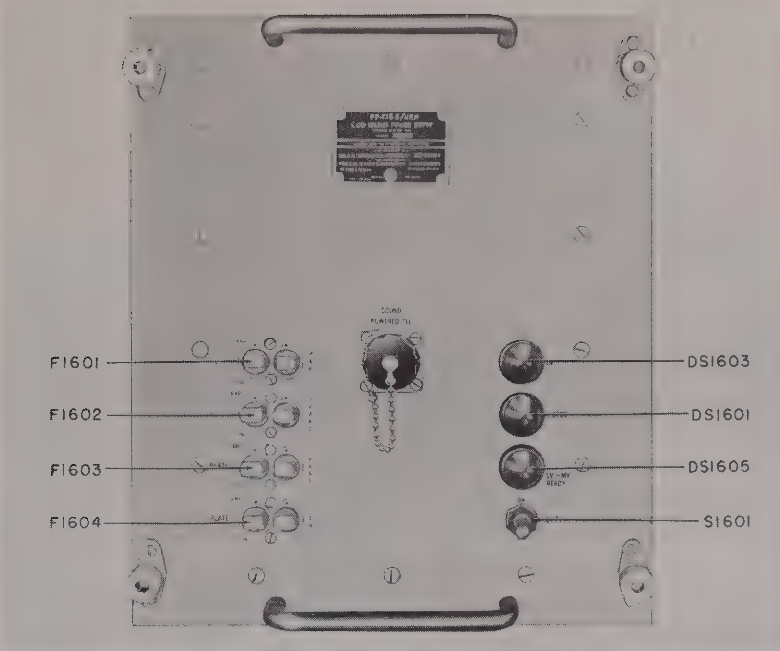


Figure 4-10. Low Voltage Power Supply PP-1766/URN, Front Panel View

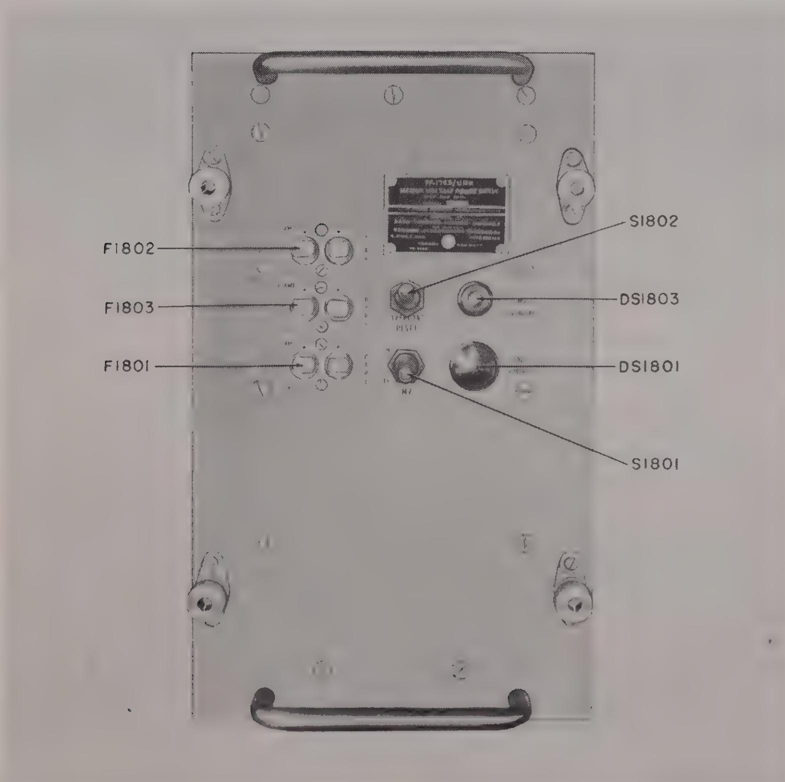


Figure 4-11. Medium Voltage Power Supply PP-1765/URN, Front Panel View

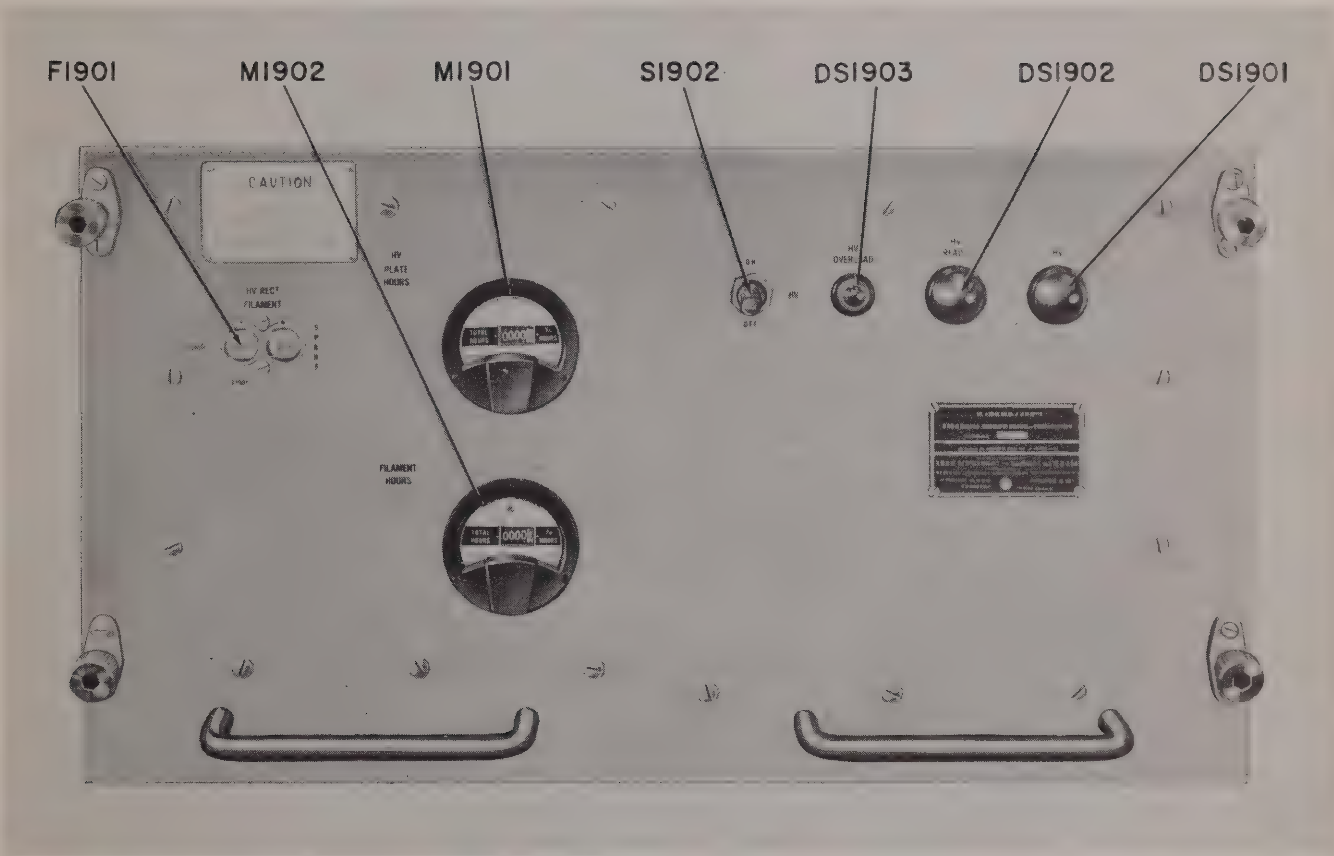


Figure 4-12. High Voltage Power Supply PP-1763/URN or PP-1764/URN, Front Panel View

SECTION 5

OPERATOR'S MAINTENANCE

1. ROUTINE CHECKS.

The following Routine Check Chart, table 5-1, covers items to be checked by the operator. These checks shall be performed daily, or each time the radio beacon is turned on, to insure normal operation.

TABLE 5-1. ROUTINE CHECK CHART

WHAT TO CHECK	HOW TO CHECK	INDICATIONS AND CORRECTIVE ACTION
POWER DISTRIBUTION AND CONTROL		
Panel fuses. See figures 4-1 and 4-7.	Inspect all the indicating fuses on the receiver-transmitter group and the power supply assembly.	A glow in one of the fuse caps indicates a blown fuse. If a glow appears, replace blown fuse. If the fuse blows a second time, call a technician.
Cabinet blowers. See figures 4-1 and 4-7.	Inspect the amber AIR SW OPEN lamps on the amplifier-modulator (DS1303), on the panel of the blower compartment of the receiver-transmitter group (DS901), and on the blower and transformer compartment of the power supply assembly (DS1001).	If one of the lamps is lit, one of the blowers is not working properly. Stop the equipment and report the trouble to the technician. Note: When the MASTER SWITCH is first turned to STANDBY or ON, the AIR SW OPEN lamps will light momentarily. This is normal, as the air switches do not close until the blowers reach full speed.
Control-duplexer panel lamps.	Inspect the blue MAIN POWER neon lamp DS1102.	If not lit, check for blown fuses. If a blown fuse is not found, report the trouble to the technician.

TABLE 5-1. ROUTINE CHECK CHART (cont)

WHAT TO CHECK	HOW TO CHECK	INDICATIONS AND CORRECTIVE ACTION
POWER DISTRIBUTION AND CONTROL (cont)		
	Inspect the white FIL ON and ANTENNA CONTROL ON lamps, DS1101 and DS1103.	The lamps should be lit, If not, check that the switches are on; if they are, report to the technician.
Regulated filament transformer voltage.	Read on SUPPLY VOLTS meter on control-duplexer panel.	Meter should read exactly 120 volts. If not, open the control duplexer unit drawer, manually cheat the interlock, loosen lock on the ADJUST FOR 120 V knob, and adjust knob until voltage is correct, then tighten lock.
Unregulated 120 V. A. C. line voltage.	Press the LINE - REG FIL BUS switch to the LINE position.	If the line voltage is not 120 V ±10 percent, report it to the technician.
RADIO RECEIVER R-824/URN		
Panel lamp.	Inspect the white POWER ON lamp on the radio receiver panel.	If the light is not lit, check the POWER ON switch on the radio receiver panel; if the switch is on, report the trouble to the technician.
Voltages.	Set METER SELECTOR switch to B+, 200 VFS.	Correct voltage is +150 ±5 volts. Full-scale deflection is equivalent to +200 volts. Therefore, the meter should read 75 ±2.5 divisions on the calibrated scale. If the reading is incorrect, report it to the technician.
	Set METER SELECTOR switch to C-, 200 VFS.	Correct voltage is -105 ±5 volts. Full-scale deflection is equivalent to -200 volts; therefore, the meter should read 52.5 ±2.5 divisions on the calibrated scale. If the reading is incorrect, report it to the technician.

TABLE 5-1. ROUTINE CHECK CHART (cont)

WHAT TO CHECK	HOW TO CHECK	INDICATIONS AND CORRECTIVE ACTION
RADIO RECEIVER R-824/URN (cont)		
	After ten minutes warm-up, set METER SELECTOR switch to SQUITTER CONTROL, -10 VFS.	Correct voltage is -5 ±1.0 volts (rapid 0.1 -volt fluctuation is normal). Full-scale deflection is equivalent to -10 volts; therefore meter should read 50 ±10 divisions on the calibrated scale. If the reading is incorrect, report it to the technician.
CODER-INDICATOR KY-235/URN		
Power.	Inspect the white POWER ON lamp on the coder-indicator front panel.	If the lamp is not lit, check the POWER ON switch on the coder-indicator panel; if the switch is on, report the trouble to the technician.
	Check that amber ANTENNA CONTROL lamp is burning steadily.	Blinking of the lamp indicates trouble in antenna control circuits. If the light is blinking, call the technician.
Erection of antenna.	While system is operating, ANTENNA POSITION SELECTOR switch should be in STABILIZED position for shipboard installations or in the STOW position for shore installations.	STOW position is to be used for erection of the antenna before the system is placed in operation.
Antenna servos meter.	Shore based only. Check that the speed error and azimuth readings are not in the red portion of the meter scale. Shipboard only. Check that the speed, roll, pitch, and azimuth error readings are not in the red portion of the meter scale.	A steady reading in the red portion of the meter scale is an indication of trouble in the antenna servos. Report this condition to the technician.

TABLE 5-1. ROUTINE CHECK CHART (cont)

WHAT TO CHECK	HOW TO CHECK	INDICATIONS AND CORRECTIVE ACTION
CODER-INDICATOR KY-235/URN (cont)		
Identification keyer. (See figure 4-8.)	Open coder-indicator drawer to gain access to the identification keyer, manually short the interlock, and check to see that the keyer motor and code wheel are rotating and that the keyer switch is operating smoothly.	The keyer motor and code wheel should be rotating and the keyer switch operating smoothly; if not, report it to the technician.
Magnetic variation (shipboard).	As often as necessary, and at least daily, check that the proper value of magnetic variation is set.	Magnetic variation changes as the ship's position changes. For detailed instructions on setting the magnetic variation, refer to paragraph 9 of Section 4.
POWER SUPPLIES (figures 4-10, 4-11, and 4-12).		
Panel lamps.	Inspect the LV-MV READY and HV READY lamps on the low- and high-voltage power supplies respectively.	The LV-MV READY lamp, DS1605, should be lit after one minute of operation. The HV READY lamp, DS1902, should be lit after five minutes of operation. If lamps are not lit after proper time interval, report the trouble to the technician.
	Inspect the LV (DS1603), and -375 V (DS1601) lamps on the low-voltage power supply panel; the +700 V +1000 V lamp (DS1801) on the medium-voltage power supply panel and the HV lamp (DS1901) on the high-voltage supply panel.	The LV, -375 V and +700 V +1000 V lamps should light after one minute of operation, and the HV lamp should light after five minutes of operation. If the lamps are not lit after the proper time interval, report the trouble to the technician.
	Inpsect the amber MV OVERLOAD lamp DS1803 on the panel of	If one or both of these lamps are lit, report the trouble to the technician.

TABLE 5-1. ROUTINE CHECK CHART (cont)

WHAT TO CHECK	HOW TO CHECK	INDICATIONS AND CORRECTIVE ACTION
POWER SUPPLIES (figures 4-10, 4-11, and 4-12). (cont)		
	the low-voltage power supply and the HV OVER-LOAD, DS1903 on the panel of the high-voltage power supply.	
Output voltages.	Turn the meter selector switch under the DC SUPPLY VOLTAGE meter on the frequency multiplier-oscillator to each of the indicated voltages. (The 700-volt position applies to Radio Set AN/GRN-9 only.)	If the meter readings are not within ±2% of what the meter selector switch indicates it should read (except the +700V which, depending on load conditions, will give a reading between 700 and 900 volts), report the trouble to the technician.
TRANSMITTER		
Frequency multiplier-oscillator lamps (figure 4-5).	Check the white OVEN lamp, DS1403.	If the OVEN lamp is not lit, report the trouble to the technician.
	Check the white NORMAL lamp, DS1402	When the radio set is first turned on, the NORMAL lamp will light. After the crystal oven has reached operating temperature, the NORMAL lamp will go out. Thereafter, the NORMAL lamp will go off and on as the oven heating element goes off and on.
Frequency multiplier-oscillator tuning meter (figure 4-5).	Read tuning meter M1402 on the frequency multiplier-oscillator front panel while turning switch S1402.	Note any variation from values given in log showing daily readings of all switch positions on this meter. Call the technician if any reading varies more than 5% from the logged readings.
Amplifier-modulator lamps (figure 4-6).	Check that the white FIL lamp DS1301, and the red +700 V lamp DS1302,	If either of these lamps is not lit, report it to the technician. The FIL

TABLE 5-1. ROUTINE CHECK CHART (cont)

WHAT TO CHECK	HOW TO CHECK	INDICATIONS AND CORRECTIVE ACTION
TRANSMITTER (cont)		
	are lit. (The 700-volt lamp applies to Radio Set AN/GRN-9 only.)	lamp should come on as soon as the amber air-flow switch goes out. On Radio Set AN/GRN-9 the +700 V lamp should come on when the HV lamp on the high-voltage power supply comes on.
Amplifier-modulator beam current (figure 4-6).	Read CHARGING CURRENT meter M1301 on the amplifier-modulator front panel.	For Radio Set AN/GRN-9 the beam current should be from 190 to 210 ma. For Radio Sets AN/GRN-9A and AN/SRN-6 the beam current should be from 80 to 100 ma.
High-voltage power supply (figure 4-12).	Read HV SUPPLY meter on the amplifier-modulator front panel.	High voltage should be approximately 12,000 volts ±1,000 volts. Call the technician if it exceeds this tolerance in either direction.

2. RADIO BEACON OPERATOR'S PERFORMANCE CHECKS USING BUILT-IN TEST EQUIPMENT - GENERAL.

It is desirable to make sure that the radio beacon meets certain minimum performance requirements. The series of tests described below is intended to serve to determine whether or not the radio beacon is operating properly, and whether or not adjustments for optimum performance are required. The test procedures described in the following paragraphs are based on using the built-in test equipments. The checks should be performed daily. It is not necessary to turn off the radio beacon to perform the checks.

The built-in test equipment must be interconnected as shown in figure 5-1 so that the special test described in paragraphs 3 to 11 of this section may be performed.

3. PRELIMINARY SETTINGS OF FRONT PANEL CONTROLS ON PULSE ANALYZER-SIGNAL GENERATOR TS-890/URN-3.

(See figure5-2.)

Before making any tests with Pulse Analyzer-Signal Generator TS-890/URN-3, set up the front panel controls as follows:

a. Set OUTPUT ATTENUATOR to 0 DBM.

b. Set INPUT ATTEN. SELECTOR control to maximum attenuation.

c. Set BAND SHIFT switch on 0.

d. Set MODULATION SELECTOR on C. W.

e. Set CHANNEL SELECTOR control to the applicable channel.

Note

If the built-in crystal oscillator is to be used as a frequency generating source, omit steps f, g, and h, below.

f. Set MAIN TUNING control to applicable channel.

g. Set OSCILLATOR SELECTOR in the V.F.O. CALIBRATE position.

h. Adjust V.F.O. CALIBRATE control until a zero beat is heard in headphone plugged into V.F.O. CALIBRATE JACK.

i. Set OSCILLATOR SELECTOR switch to either REF. OSC. position (for crystal control) or to V.F.O. position, depending on which oscillator is to be used as the generating source.

j. Adjust for a 0 reading on the OUTPUT LEVEL indicator, using its ZERO SET control

k. Set INTERROGATE switch to ON.

Note

Before proceeding with the next step, Pulse-Sweep Generator SG-121A/URN-3 (figure 5-6) must be energized and warmed up for at least two minutes.

l. Set the POWER SET control to midscale.

m. Adjust the PULSE AMPLITUDE control, located on the SG-121/URN-3 Pulse-Sweep Generator, to obtain a midscale reading (100) on the OUTPUT LEVEL INDICATOR. (See figure 5-8.)

n. Adjust the CHANNEL SELECTOR slightly for a maximum reading on the OUTPUT LEVEL INDICATOR.

Note

There is a time lag between the application of signal to the OUTPUT LEVEL INDICATOR and the indication of the

power level. When taking readings on this meter, allow time for the needle to stabilize.

o. Readjust the PULSE AMPLITUDE control on SG-121A/URN-3 to obtain a midscale reading (100) on the OUTPUT LEVEL INDICATOR.

p. Adjust the ZERO SET control (of the POWER COMPARISON INDICATOR) to obtain reading of zero on the POWER COMPARISON INDICATOR.

q. Set the MODULATION SELECTOR to PULSE.

Note

Pulse Analyzer-Signal Generator TS-890/URN-3 is now ready for use in making tests. Upon completion of the tests shut equipment down by turning the INTERROGATE and power switches to the OFF positions.

4. PEAK POWER MEASUREMENTS.

Peak power delivered to the antenna must be 5.0 kw for Radio Set AN/GRN-9. In the case of Radio Sets AN/GRN-9A or AN/SRN-6, the peak power should be 7.5 kw, or greater. To make this measurement, proceed as follows:

Step 1. Turn the FUNCTION switches on the oscilloscope (figure 5-3) and power meter-pulse counter (figure 5-4) to position 1, OPERATING TEST.

Step 2. With the radio set fully operative, observe the transmitter r-f envelope on the oscilloscope (OS-54/URN-3). It should appear as shown in figure 5-5.

Note that gain, sweep speed, and trigger selection controls on the oscilloscope are automatically set as required for this test by internal controls associated with position 1 of the FUNCTION switch. Adjustment procedures for these controls are described in the Technical Manual NAVSHIPS 92778 supplied with Oscilloscope OS-54/URN-3. The SCALE ILLUMINATION, TRIG AMP and SWEEP STABILITY controls, and the SIGNAL DELAY SELECTOR and MARKER SEL switches are the only other controls having any effect. These should be set, respectively, to the counterclockwise, 5, 5,OUT, and OFF positions. If a stable sweep is not achieved with these settings adjust the TRIG AMP and SWEEP STABILITY controls as required.

Step 3. Turn the PEAK PWR VOLTAGE control on Power Meter-Pulse Counter TS-891/URN-3 completely counterclockwise to its minimum setting.

Step 4. Depress the RF POWER switch on the power meter-pulse counter and maintain it in that position while making the measurement.

Step 5. While observing the pulse envelope on the oscilloscope, turn the PEAK PWR VOLTAGE control clockwise, until the negative pulses just touch the baseline. At this point stop advancing the control and read the r-f power directly in kilowatts, on the PEAK RF POWER meter. Release the RF POWER switch.

REQUIREMENT: A reading of 5 kw or over for Radio Set AN/GRN-9 or 7.5 kw or over for Radio Set AN/GRN-9A and AN/SRN-6 is considered normal. If the requirement is not met, report the trouble to the technician.

5. VISUAL PULSE SHAPE.

Step 1. Turn the FUNCTION SWITCH on Oscilloscope OS-54/URN-3 to position 1, OPERATING TEST.

Step 2. With Radio Set AN/GRN-9 fully operative, observe the r-f envelope on the oscilloscope. It should appear as shown in figure 5-5.

Step 3. Utilizing the 1-microsecond MARKER SEL switch on the oscilloscope measure spacing between pulses. Spacing should be 12 ±0.5 microseconds.

Step 4. Measure the pulse width at the half-amplitude points.

REQUIREMENT: The correct pulse width is 3.5 ±0.4 microseconds. If the requirement is not met, report the trouble to the technician.

6. OUTPUT PULSE COUNT.

Step 1. Turn the FUNCTION SWITCH on the power meter-pulse counter to position 1, OPERATING TEST.

Step 2. Set the COUNTER SELECTOR switch to +.

Step 3. Set the RANGE SWITCH to X10.

REQUIREMENT: The out pulse count with the radio set operating properly should be 7,200 ±180 pulses per second (3,600 pulse-pairs). If the requirement is not met report the trouble to the technician.

7. OUTPUT PULSE SPECTRUM TEST.

The built-in test equipment includes a sharply tuned r-f voltmeter (the analyzer portion of the Signal Generator-Pulse Analyzer TS-890/URN-3) which is used to compare sideband energy with center frequency energy for an accurate check of pulse shape. The test equipment is highly specialized for this purpose. The test is made with the beacon operating under normal traffic conditions.

Note

The original version of Pulse Analyzer-Signal Generator TS-890/URN-3 was designed to measure the radiated spectrum of Radio Set AN/URN-3. The spectrum requirements for Radio Sets AN/GRN-9, AN/GRN-9A, and AN/SRN-6 are more rigid than spectrum requirements for AN/URN-3. Therefore, when checking the spectrum of Radio Sets AN/GRN-9, AN/GRN-9A, and AN/SRN-6, a modified version of TS-890/URN-3, which can measure a spectrum 60 db below the carrier level at one megacycle either side of the carrier frequency, must be used.

Step 1. Make preliminary setup of pulse analyzer-signal generator as directed in paragraph 3.

Step 2. Remove the connection at the RECEIVER INPUT jack of the Pulse Analyzer-Signal Generator TS-890/URN-3.

Step 3. Place the MODULATOR SELECTOR switch of the TS-890/URN-3 to the CW position. Recheck that the INTERROGATE switch is in the OFF position; otherwise test interrogations will block out normal beacon traffic.

Step 4. Connect the RECEIVER INPUT receptacle on the front panel of the TS-890/URN-3 to the RF OUTPUT jack on the control-duplexer. Figure 5-9 illustrates correct beacon output pulses.

Step 5. Adjust the INPUT ATTEN. SELECTOR for a midscale reading (100) on the POWER COMPARISON INDICATOR. Allow the meter pointer to stabilize before continuing to step 6.

Note

If no reading is obtained on the POWER COMPARISON INDICATOR, check that the BAND SHIFT control is in ZERO position, and that the OSCILLATOR SELECTOR control is in either REF OSC or VFO.

Step 6. Vary the position of the BAND SHIFT control through its five positions.

REQUIREMENT: If the reading of the POWER COMPARISON INDICATOR remains at midscale or moves to a position less than midscale for the four BAND SHIFT positions, then the beacon pulse shape is within specified limits. If, when going through the four positions of the BAND SHIFT switch, the POWER COMPARISON INDICATOR shows a reading higher than midscale, then too steep a pulse is indicated and tuning of the beacon is required. If the requirement is not met, report the trouble to the technician.

8. SQUITTER COUNT.

Step 1. Turn the FUNCTION SWITCH on Power Meter-Pulse Counter TS-891/URN-3 to position 2, RECEIVER SENSITIVITY.

Step 2. Set the COUNTER SELECTOR switch on Power Meter-Pulse Counter TS-891/URN-3 to the SQUITTER position.

Step 3. Set the RANGE SWITCH on the TS-891/URN-3 to the X10 position.

REQUIREMENT: The SQUITTER rate, as read on the PULSE COUNT METER, should be 2,700 ±90 pulses per second. If the requirement is not met, report the trouble to the technician.

9. REPLY COUNT (RECEIVER SENSITIVITY).

Step 1. Make preliminary setup of front panel controls as directed in paragraph 3.

Note

Before proceeding, check that setting of INPUT ATTENUATION SELECTOR on Pulse Analyzer-Signal Generator TS-890/URN-3 is at a maximum workable attenuation so as not to load the beacon, and cause the squitter voltage to go positive. In a typical radio beacon, a setting of 35 db is normal.

Step 2. Set MODULATION SELECTOR switch on Pulse Analyzer-Signal Generator TS-890/URN-3 to PULSE position.

Step 3. Connect a coaxial test lead from the RF OUTPUT jack on Pulse Analyzer-Signal Generator TS-890/URN-3 to the ANTENNA REFLECTED jack on control-duplexer.

Step 4. Set FUNCTION SWITCH on Pulse Analyzer-Signal Generator TS-890/URN-3 to position 2, RECEIVER SENSITIVITY.

Step 5. Set COUNTER SELECTOR SWITCH on Power Meter-Pulse Counter TS-891/URN-3 to REPLY RATE.

Step 6. Set RANGE SWITCH on Power Meter-Pulse Counter TS-891/URN-3 to X10.

Step 7. Set PRF RANGE on Pulse Sweep Generator SG-121A/URN-3 to 1000 and PRF MULTIPLIER to X1.

Step 8. Set the PULSE CODING μsec switch on SG-121A/URN-3 to the number 12 position.

Step 9. Advance the OUTPUT ATTENUATOR on the Pulse Analyzer-Signal Generator TS-890/URN-3 until the reply count is reduced to 600.

Step 10. Read the RF OUTPUT DBM scale on the OUTPUT ATTENUATOR.

REQUIREMENT: The RF OUTPUT DBM should be 93 db or more. If this requirement is not met, report the trouble to the technician.

Note

> Receiver sensitivity is defined as the signal level required to obtain 60 percent reply to an interrogating signal. With the pulse-pair repetition rate set at 1,000 pulse-pairs per second, a reply rate of 600 will indicate 60 percent response.

Step 11. Test the 12-microsecond acceptance decoder of the radio receiver to determine whether it is working properly. This is done by observing whether the reply rate remains the same for the 11.5-microsecond and 12.5-microsecond positions of the PULSE CODING microsecond switch. The number of replies should be reduced considerably for the 11- and 13-microsecond positions of the switch.

REQUIREMENT: The radio receiver decoder is designed to pass all pulse-pairs with a spacing of from 11.5 to 12.5 microseconds between pulses of a pair. Pulse-pairs with spacings of 11 microseconds or less, and those of 13 microseconds or greater, will either be attenuated or decoupled.

Step 12. Repeat steps 7 through 9 changing the PRF RANGE setting to 200 and PRF MULTIPLIER to X1.

REQUIREMENT: A minimum reply count of 120, at 93 db, should be obtained.

Step 13. Repeat steps 7 through 9 changing the PRF RANGE setting to 250 and PRF MULTIPLIER TO X10.

REQUIREMENT: A minimum reply count of 1,500 replies at 93 db. Report the trouble to the technician if the requirements are not met.

10. REFERENCE BURST PULSE COUNT.

Step 1. Turn the FUNCTION SWITCH to position 2, RECEIVER SENSITIVITY on Oscilloscope OS-54/URN-3.

Step 2. The presentation shown in figure 5-6 should appear on the oscilloscope.

Note

> TRIGGER AMP. and SWEEP STAB. controls of the oscilloscope may have to be adjusted to obtain figure 5-6.

REQUIREMENT: Normal indication, as shown in figure 5-6, is six auxiliary reference burst pulse-pairs (heavy pulses) and 12 north reference burst pulse-pairs (light pulses). Five of the north reference pulse-pairs will be superimposed on the auxiliary pulse pairs. A north pulse-pair should be visible; one pulse of the pair to the left, and one pair of the pulse to the right of the fourth and ninth auxiliary pulses. Seven more north burst pulse-pairs should

be counted at the end of the auxiliary burst. If the requirement is not met, report the trouble to the technician.

11. ZERO DISTANCE AND VIDEO DELAY CHECKS.

Step 1. Set the FUNCTION switches on the oscilloscope and power meter-pulse counter to position 3, SYSTEM DELAY.

Step 2. Set the pulse-sweep generator INT-SWEEP-EXT switch to SWEEP and the PULSE CODING USEC switch to 12. Set the OVERALL DELAY-VIDEO DELAY switch to 1.

Step 3. Adjust Pulse Analyzer-Signal Generator TS-890/URN-3 to provide a modulated signal by following the procedure of paragraph 3, above. At the completion of those steps set the MODULATION SELECTOR to PULSE and set the RF OUTPUT attenuator to -35 DBM.

Step 4. Observe the display on the oscilloscope and, if necessary, adjust the controls in the top row for a clear presentation. Note that there are two sets of pulses displayed: the radio beacon output pulse and a pair of rectangular reference pulses. Adjust the pulse sweep generator BALANCE control so that both sets of pulses have equal amplitude. This should provide a presentation similar to that shown in figure 5-7a.

Step 5. If a pattern such as that shown in figure 5-7A is obtained (that is, with the radio beacon output pulse-pair to the left of the reference pulse-pair), the overall delay is less than 50.2 microseconds and the next step may be performed. If it is to the right, the zero delay is too great and must be adjusted. If the requirement is not met, report the trouble to the technician.

Step 6. Change the switch setting (on the pulse sweep generator) to OVERALL DELAY 2. Observe that the pattern is as shown in figure 5-7b. If not, that is, if the radio beacon output is to the left of the reference pulse-pair, the zero distance delay is less than 49.8 microseconds and must be adjusted. Ideally, output pulses should be as much to the right of the reference pulse (switch position 1) as they are to the left (switch position 2).

Step 7. Check video delay in the same manner, referring to the waveform, shown in figures 5-7f and d, for CRYSTAL SELECTOR switch positions VIDEO DELAY 3 and 4, respectively. If trouble is indicated, report to the technician.

Note

> The delay error indicated by the above checks is magnified by the type of presentation used. The check is intended as an accurate,readable go-no-go gauge and should be so used.

12. REPLACEMENT OF TUBES AND FUSES.

NOTICE TO OPERATORS

Operators shall not perform any of the following emergency maintenance procedures without proper authorization.

a. FUSE FAILURE. - All fuses used in the radio beacon are held in fuseholders that have neon lamps in their caps that glow when the fuse is blown. When any apparent improper functioning of the radio beacon occurs, the indicating fuses should be checked before proceeding with other tests. (See figures 4-1 and 4-7.) For fuse locations refer to table 5-2.

WARNING

Never replace a fuse with one of higher rating unless continued operation of the equipment is more important than probable damage. Use spare fuses located adjacent to the faulty fuse. If a fuse burns out immediately after replacement, do not replace it a second time until the cause has been corrected.

b. TUBE LOCATIONS. - To replace defective electron tubes, loosen the captive screws holding the particular unit in the cabinet and slide the unit to its fully extended position. For tube locations refer to table 5-3.

c. REPLACING TRIPLER TUBE V1504 AND FINAL R-F AMPLIFIERS V1505 AND V1506 IN FREQUENCY MULTIPLIER-OSCILLATOR. - Whenever a tube is replaced in one of the r-f cavities, Z1501, Z1502 or Z1503, the cavities should be inspected and cleaned. Examine the cavity contacts to make sure that they have not been bent as a result of an improperly seated tube. It is possible that metal filings from the threads on the tube holder and anode clip have entered the cavity as a result of extensive tube replacement. The cavity should be cleaned with compressed air of moderate pressure to blow out any filings or dirt.

To remove a type 2C39A tube from cavity Z1501, Z1502, or Z1503 proceed as follows:

Step 1. Remove the Tru-arc ring from the top cavity tuning adjustment by spreading the ring and lifting it upward.

Step 2. Remove the cavity top cover and spring washer.

Step 3. Turn the tube holder in a counterclockwise direction by using a heavy screwdriver in the tuning adjustment, until the tube and tube holder are free and can be lifted from the cavity.

Step 4. To remove the tube from the tube holder, loosen the locking ring, unscrew the anode shell, and push the tube out of the anode cup.

Step 5. To replace the tube, follow in reverse the procedure outlined in steps 1 through 4.

Step 6. It is now necessary to retune the cavity, and possibly the transmitter portion of the radio beacon. Call the technician.

d. REPLACING THE SAL-39A KLYSTRON.
(See figure 3-15.)

CAUTION

Because of the special construction of the klystron tube, V1304, of the amplifier-modulator, the following procedure for replacing this tube should be followed explicitly in order to reduce the possibility of breaking the tube seals.

(1) Turn the master switch to OFF. The main blower will continue to operate for one minute after voltage is removed from the relays and will then stop automatically.

(2) Pull the amplifier-modulator out to its fully extended position.

(3) Open the access door on the front panel.

(4) Detach the cables from the klystron r-f input and output terminals. Use gloves if the tube is hot. The r-f output connection should be detached with the special pin wrenches provided, located in the control-duplexer.

CAUTION

Care must be taken when detaching the r-f output cable to the klystron to maintain equal torque on the two pin wrenches in order that the torque required to tighten the cable connector is not applied to the klystron terminals. The bend in the cable should be maintained so that transverse force is not applied to the output terminal.

(5) Remove the klystron cathode shield from its locked position.

(6) Detach the flexible klystron heater leads at the bulkhead bushing located on the rear surface of the klystron compartment. Do not detach the flexible leads at the klystron heater terminal rods.

(7) Place the cup shield provided with the klystron through the left-side access hole and secure it over the heater-cathode end of the klystron with the screws provided.

(8) Remove the band from around the input cavity of the klystron.

(9) Remove the anode connection (located on the right side of the unit) from the klystron.

(10) Remove the four bolts at the anode end of the klystron, holding the klystron to the modulator chassis.

(11) Lift the klystron up off its mountings by gripping the klystron at both the anode end and the first cavity end from underneath. The klystron can now be removed by twisting it so that the input and output terminals do not hit the front panel, by moving the klystron to the left, and by bringing the anode end out first.

CAUTION

The klystron should not be held by its filament or r-f terminals. Gloves should be worn while changing the tube for protection of personnel against burns.

(12) Before installing the new klystron, preset the spacings of the cavity rings to the required value for the desired frequency of operation. Consult the calibration chart provided with the particular klystron being installed. The chart contains three curves, one for each of the three cavities, INPUT, MIDDLE, and OUTPUT. Determine the channel at which the radio beacon is to operate, and choose the appropriate transmitter frequency. Using the chart supplied with the new klystron, determine the proper spacing required for each of the three cavities. On each calibration curve of the chart, the transmitter frequency is the ordinate, and the spacing (in thousandths of an inch) between the inside surfaces of the flanges is the abscissa. Use jaw-type inside micrometer calipers to gage the spacing between rings. Use the adjusting wrench provided to adjust each one of the three cavities. It is very important that the flanges be moved parallel to each other while they are being adjusted. This is accomplished by turning any one adjusting nut no more than one full turn, before turning the other nut of the corresponding flange by the same amount. This may necessitate repeated adjustments of the nuts until the desired parallel condition and the required spacing are obtained.

CAUTION

Some klystrons are shipped without the flexible heater leads. In that case it will be necessary to remove the flexible leads from the old klystron, and attach them to the one being installed. Extreme care must be exercised during this operation to prevent cracking the heater rod seal.

(13) Check that the cup shield provided with the new klystron is over the heater terminals. Remove the two back screws securing the cup shield in place. This is necessary because the back screws become inaccessible when the klystron is inside the amplifier-modulator. Do not remove the two front screws at this time.

(14) Loosen the four cradle bolts and tilt the cradle forward, pushing the band up and to the rear of the compartment. Loosen the bolt holding the cradle to the chassis, and push it all the way to the right.

(15) Place the klystron into the klystron compartment, cathode end first, and position the anode end on the two supports provided. Allow the other end to rest on the cradle.

(16) Insert and tighten the four bolts in the anode plate. Secure grounding strap to the anode.

(17) Position the cradle directly under the raised ring on the input cavity. Tighten the bolt.

(18) Loosen the two bolts on the cradle directly under the klystron and position the cradle firmly against the klystron. Hold in this position and tighten the bolts.

(19) Secure the band around the klystron.

(20) Attach the r-f input and output cables.

CAUTION

Care must be taken when attaching the r-f output cable to the klystron to maintain equal torque on the two pin wrenches in order that the torque required to tighten the output cable connector is not applied to the klystron terminal. The bend in the cable should be maintained so that transverse force is not applied to the output terminal.

(21) Remove the cup shield from the filament end of the klystron and attach the flexible leads to the bulkhead terminals. The heater terminal is the center terminal. The cathode terminal (marked HK) is the outer terminal.

CAUTION

Before energizing a new klystron, or one that has not been used for a period of three months, be sure the klystron is aged according to the procedure outlined in paragraph 17, Section 3.

e REPLACING THE SAL-89 KLYSTRON. - The procedure for replacement of SAL-89-type klystrons is the same as the procedure for replacement of SAL-39A klystrons, except for the connection of a flexible lead to the grid terminal at the filament end of the klystron. (See figure 3-18.)

TABLE 5-2 FUSE LOCATIONS

SYMBOL	LOCATION	PROTECTS	AMPS
F501	Front panel of Radio Receiver*	Main power bus	3
F502	Front panel of Radio Receiver*	Main power bus	3
F601A	Front panel of Coder-Indicator*	Main power bus	3
F601B	Front panel of Coder-Indicator*	Main power bus	3
F901	Front panel of Receiver Transmitter Cabinet (Radio Set AN/GRN-9 & AN/GRN-9A)	Cabinet blowers	3
F902	Front panel of Receiver Transmitter Cabinet (Radio Set AN/GRN-9 & AN/GRN-9A)	Cabinet blowers	3
F903	Front panel of Receiver Transmitter Cabinet (Radio Set AN/GRN-9 & AN/GRN-9A)	Cabinet blowers	3
F905	Front panel of Receiver Transmitter Cabinet (Radio Set AN/GRN-9 & AN/GRN-9A)	Cabinet blowers	2
F906	Front panel of Receiver Transmitter Cabinet (Radio Set AN/GRN-9 & AN/GRN-9A)	Cabinet blowers	2
F907	Front panel of Receiver Transmitter Cabinet (Radio Set AN/GRN-9 & AN/GRN-9A)	Cabinet blowers	2
F909	Front panel of Receiver Transmitter Group (Radio Set AN/SRN-6 only)	Cabinet blowers	2
F910	Front panel of Receiver Transmitter Group (Radio Set AN/SRN-6 only)	Cabinet blowers	2
F911	Front panel of Receiver Transmitter Group (Radio Set AN/SRN-6 only)	Cabinet blowers	2
F913	Front panel of Receiver Transmitter Group (Radio Set AN/SRN-6 only)	Cabinet blowers	1
F914	Front panel of Receiver Transmitter Group (Radio Set AN/SRN-6 only)	Cabinet blowers	1

For all footnotes, see end of table.

TABLE 5-2 FUSE LOCATIONS (Cont'd)

SYMBOL	LOCATION	PROTECTS	AMPS
F915	Front panel of Receiver Transmitter Group (Radio Set AN/SRN-6 only)	Cabinet blowers	1
F1001	Front panel of Power Supply Assembly** (Radio Set AN/GRN-9 & AN/GRN-9A)	HV plate supply	15
F1002	Front panel of Power Supply Assembly** (Radio Set AN/GRN-9 & AN/GRN-9A)	HV plate supply	15
F1003	Front panel of Power Supply Assembly** (Radio Set AN/GRN-9 & AN/GRN-9A)	HV plate supply	15
F1004	Front panel of Power Supply Assembly**	Convenience outlets	15***
F1005	Front panel of Power Supply Assembly**	Convenience outlets	15***
F1006	Front panel of Power Supply Assembly** (Radio Set AN/GRN-9 & AN/GRN-9A)	Cabinet blowers	3
F1007	Front panel of Power Supply Assembly** (Radio Set AN/GRN-9 & AN/GRN-9A)	Cabinet blowers	3
F1008	Front panel of Power Supply Assembly** (Radio Set AN/GRN-9 & AN/GRN-9A)	Cabinet blowers	3
F1011	Front panel of Power Supply Assembly	HV plate supply	8
F1012	Front panel of Power Supply Assembly	HV plate supply	8
F1013	Front panel of Power Supply Assembly	HV plate supply	8
F1014	Front panel of Power Supply Assembly	Cabinet blowers	2
F1015	Front panel of Power Supply Assembly	Cabinet blowers	2
F1016	Front panel of Power Supply Assembly	Cabinet blowers	2
F1101	Front panel of Control-Duplexer*	Control circuits	3
F1102	Front panel of Control-Duplexer*	Control circuits	3
F1103	Front panel of Control-Duplexer*	Antenna control	15

For all footnotes, see end of table.

TABLE 5-2 FUSE LOCATIONS (Cont'd)

SYMBOL	LOCATION	PROTECTS	AMPS
F1104	Front panel of Control-Duplexer*	Antenna Control	15
F1105	Front panel of Control-Duplexer*	Control circuits	3
F1106	Front panel of Control-Duplexer*	Control circuits	3
F1107	Front panel of Control-Duplexer*	Control circuits	3
F1108	Front panel of Control-Duplexer*	Regulated filament bus	15
F1109	Front panel of Control-Duplexer*	Regulated filament bus	15
F1110	Front panel of Control-Duplexer*	Control circuits	3
F1111	Front panel of Control-Duplexer*	LV-MV plate supply neutral	15
F1301	Front panel of Amplifier-Modulator*†	Filaments	5
F1302	Front panel of Amplifier-Modulator*	Filaments	3
F1303	Front panel of Amplifier-Modulator*†	Filaments	1
F1401	Front panel of Frequency Multiplier-Oscillator*	Filaments	2
F1402	Front panel of Frequency Multiplier-Oscillator*	Crystal oven	2
F1403	Front panel of Frequency Multiplier-Oscillator*	Crystal oven	2
F1601	Front panel of Low Voltage Power Supply**	Filaments	0.75
F1602	Front panel of Low Voltage Power Supply**	Filaments	1
F1603	Front panel of Low Voltage Power Supply**	Rectifier plates	2
F1604	Front panel of Low Voltage Power Supply**	Rectifier plates	1
F1801	Front panel of Medium Voltage Power Supply**	Rectifier plates	5

For all footnotes, see end of table.

TABLE 5-2 FUSE LOCATIONS(Cont'd)

SYMBOL	LOCATION	PROTECTS	AMPS
F1802	Front panel of Medium Voltage Power Supply**	Filaments	1
F1803	Front panel of Medium Voltage Power Supply**	Filaments	1
F1901	Front panel of High Voltage Power Supply**	Filaments	3

* Receiver-Transmitter Group
** Power Supply Assembly
*** In Radio Set AN/SRN-6 fuses F1004 and F1005 are 8 Amp.
† In Radio Set AN/GRN-9 only

TABLE 5-2 FUSE LOCATIONS (cont'd)

SYMBOL	LOCATION	PROTECTS	AMPS
F1601	Front panel of Low Voltage Power Supply**	Filaments	0.75
F1602	Front panel of Low Voltage Power Supply**	Filaments	1
F1603	Front panel of Low Voltage Power Supply**	Rectifier plates	2
F1604	Front panel of Low Voltage Power Supply**	Rectifier plates	1
F1801	Front panel of Medium Voltage Power Supply**	Rectifier plates	5
F1802	Front panel of Medium Voltage Power Supply**	Filaments	1
F1803	Front panel of Medium Voltage Power Supply**	Filaments	1
F1901	Front panel of High Voltage Power Supply**	Filaments	3

* Receiver-Transmitter Group

** Power Supply-Test Set Group

TABLE 5-3 TUBE LOCATION

LOCATION	SYMBOL	FUNCTION	TYPE
a. Radio Receiver			
(1) Pre-Amplifier	V-201	I. F. Amplifier	5654/6AK5W
Subassembly	V-202	I. F. Amplifier	6J4WA
	V-203	I. F. Amplifier	5654/6AK5W
(2) I. F. Amplifier	V-301	I. F. Amplifier	5654/6AK5W
Subassembly	V-302	I. F. Amplifier	5654/6AK5W
	V-303	I. F. Amplifier	5654/6AK5W
	V-304	I. F. Amplifier	5654/6AK5W
	V-305	I. F. Amplifier	5654/6AK5W
	V-306	Discriminator	5626/6AL5W
	V-307	Video Amplifier	12AT7WA
	V-308	Clamper	5726/6AL5W
(3) Video Amplifier Subassembly	V-401	Blanking Gate	5725/6AS6W
	V-402	Video Amplifier	12AT7WA
	V-403	Decoder	5725/6AS6W
	V-404	Multivibrator	5670
	V-405	Cathode Follower	12AT7WA
	V-406	Blanking Multivibrator	5670
	V-407	Phase Inverter	5670
	V-408	Pulse Amplifier	6005/6AQ5W
(4) Power Supply Subassembly	V-501	Full Wave Rectifier	5R4WGB
	V-502	Full Wave Rectifier	6X4W
	V-503	Voltage Regulator	6080WA

TABLE 5-3 TUBE LOCATION (cont'd)

LOCATION	SYMBOL	FUNCTION	TYPE
(4) Power Supply Subassembly (cont'd)	V-504	Amplifier	5654/6AK5W
	V-505	Voltage Reference	6627/OB2WA
	V-506	Voltage Reference	6627/OB2WA
b. Coder Indicator			
(1) Video Amplifier Subassembly	V-601	15 cps Amplifier	12AT7WA
	V-602	15 cps Gate Generator	12AT7WA
	V-603	Oscillator	5670
	V-604	Amplifier	12AT7WA
	V-605	Multivibrator	12AT7WA
	V-606	Blocking Oscillator	5687WA
	V-607	Amplifier	5687WA
	V-608	Tuning Fork Oscillator	12AT7WA
	V-609	135 cps Gate Generator	12AT7WA
	V-610	Oscillator	5670
	V-611	Priority Gate	12AT7WA
	V-612	1350 cps Tone Oscillator	5670
	V-613	Amplifier	5670
	V-614	Multivibrator	5670
	V-615	Multivibrator	5687WA
(2) Power Supply Subassembly	V-701	Plate Supply Rectifier	5R4WGR
	V-702	Bias Supply Rectifier	6X4W
	V-703	Series Regulator	6080
	V-704	Control Tube	6AH6
	V-705	Bias Voltage Regulator	6627/OB2WA

TABLE 5-3 TUBE LOCATION (cont'd)

LOCATION	SYMBOL	FUNCTION	TYPE
c. Amplifier-Modulator AM-1702/ GRN-9			
(1) Modulator Driver	V-1350	Clipper Amplifier	6005/6AQ5W
	V-1351	Shunt Regulated Amplifier	6AR6
	V-1352	Shunt Regulated Amplifier	6AR6
	V-1353	Shunt Regulated Amplifier	6AR6
(2) High Level Modulator	V-1301	Shunt Regulated Keyer	5022
	V-1302	Shunt Regulated Keyer	4-1000A
	V-1303	Charging Diode	371B
	V-1304	Power Amplifier	SAL-39A
d. Amplifier-Modulator AM-1701/ URN			
(1) Power Amplifier	V-1304	Power Amplifier	SAL-89
(2) Bias Supply	V-1370	Regulator Amplifier	5654/6AK5WA
	V-1371	Voltage Reference	5651WA
	V-1372	Series Regulator	5687WA
e. Frequency Multiplier Oscillator			
(1) Video Subassembly	V-1401	Multivibrator	5814A
	V-1402	Multivibrator	5687WA
	V-1403	Amplifier	6293
	V-1404	Amplifier	6293
	V-1405	Amplifier	6293
	V-1406	Shaping Diode	6V3A

TABLE 5-3 TUBE LOCATION (cont'd)

LOCATION	SYMBOL	FUNCTION	TYPE
(1) Video Subassembly (cont'd)	V-1407	Cathode Follower	6293
	V-1408	Multivibrator	5687WA
	V-1409	Cathode Follower	5687WA
	V-1410	Voltage Regulator	5687WA
	V-1411*	Cathode Follower	6293
(2) R. F. Subassembly	V-1501	Oscillator-First Doubler	5670
	V-1502	Second Doubler	5654/6AK5W
	V-1503	Third Doubler	6J4WA
	V-1504	Tripler	2C39A
	V-1505	First Amplifier	2C39A
	V-1506	Second Amplifier	2C39A
	V-1507	Oscillator-First Doubler	5670
	V-1508	Second Doubler	5654/6AK5W
	V-1509	Third Doubler	6J5WA
	V-1510	Tripler	2C39A
	V-1511	First Amplifier	2C39A
	V-1512	Second Amplifier	2C39A
f. Low Voltage Power Supply			
	V-1601	Rectifier	5R4WGB
	V-1602	Rectifier	5R4WGB
	V-1603	Series Regulator	829B
	V-1604	Series Regulator	829B
	V-1605	Amplifier	12AT7WA
	V-1606	Voltage Reference	5651WA

* Used in Frequency Multiplier Oscillator CV-589/URN only.

TABLE 5-3 TUBE LOCATION (cont'd)

LOCATION	SYMBOL	FUNCTION	TYPE
f. Low Voltage Power Supply (cont'd)	V-1610	Rectifier	5R4WGB
	V-1611	Series Regulator	829B
	V-1612	Amplifier	12AT7WA
	V-1613	Voltage Reference	5651WA
g. Medium Voltage Power Supply			
	V-1801	Rectifier	836
	V-1802	Rectifier	836
	V-1803	Series Regulator	829B
h. Medium Voltage Power Supply	V-1804	Series Regulator	829B
	V-1805	Series Regulator	829B
	V-1806	Series Regulator	829B
	V-1807	Series Regulator	829B
	V-1808	Regulator Amplifier	12AT7WA
	V-1810	Voltage Reference	OA2WA
	V-1811	Voltage Reference	OA2WA
	V-1812	Voltage Reference	OA2WA
	V-1813	Voltage Reference	OA2WA
	V-1814	Voltage Reference	OA2WA
i. High Voltage Power Supply			
	V-1901	Rectifier	8020
	V-1902	Rectifier	8020
	V-1903	Rectifier	8020

TABLE 5-3 TUBE LOCATION (cont'd)

LOCATION	SYMBOL	FUNCTION	TYPE
i. High Voltage Power Supply (cont'd)	V-1904	Rectifier	8020
	V-1905	Rectifier	8020
	V-1906	Rectifier	8020

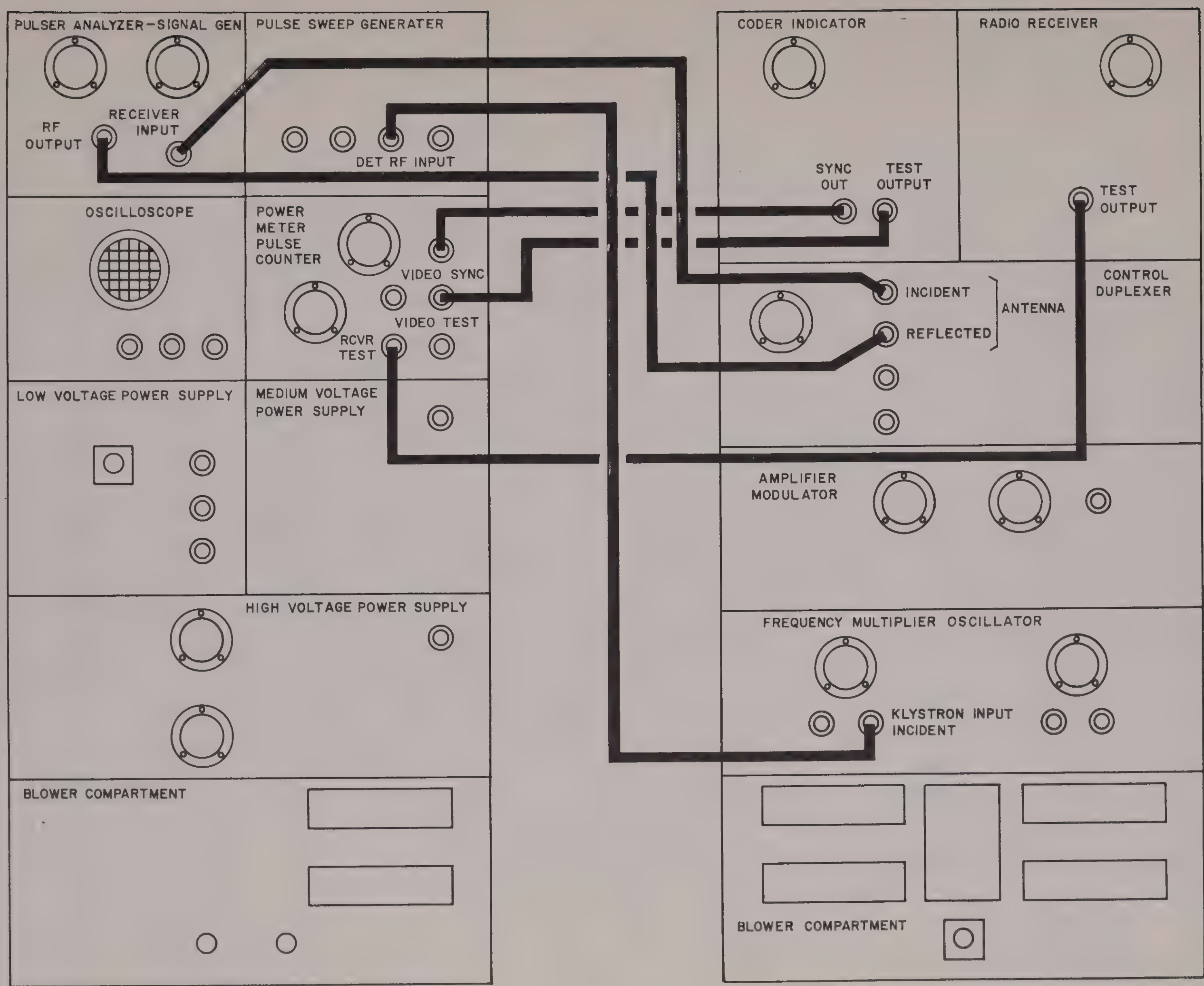


Figure 5-1. Interconnection Diagram, Test Equipment Front Panel

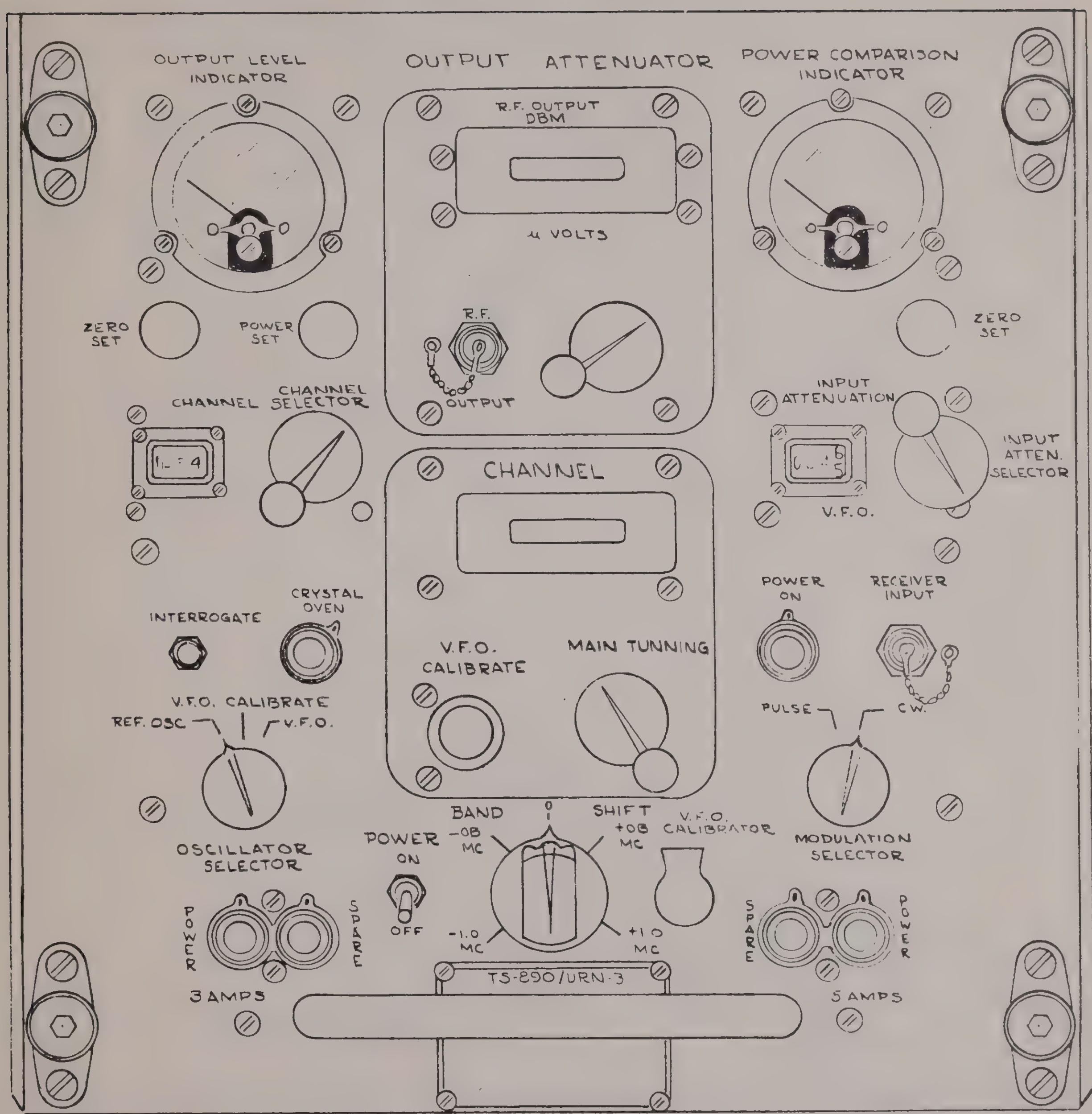


Figure 5-2. Pulse Analyzer-Signal Generator TS-890/URN-3, Front Panel

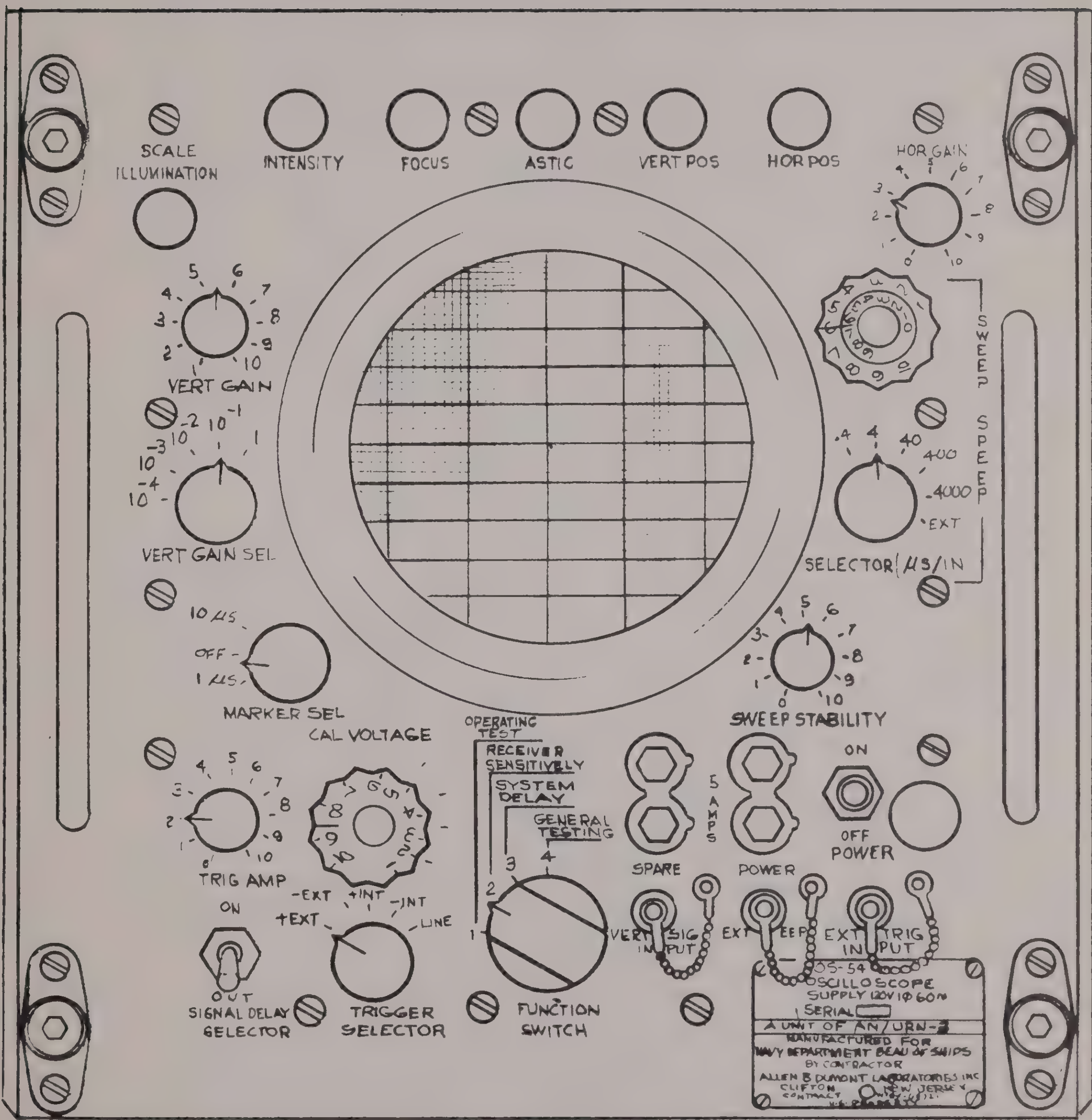


Figure 5-3. Oscilloscope OS-54/URN-3, Front Panel

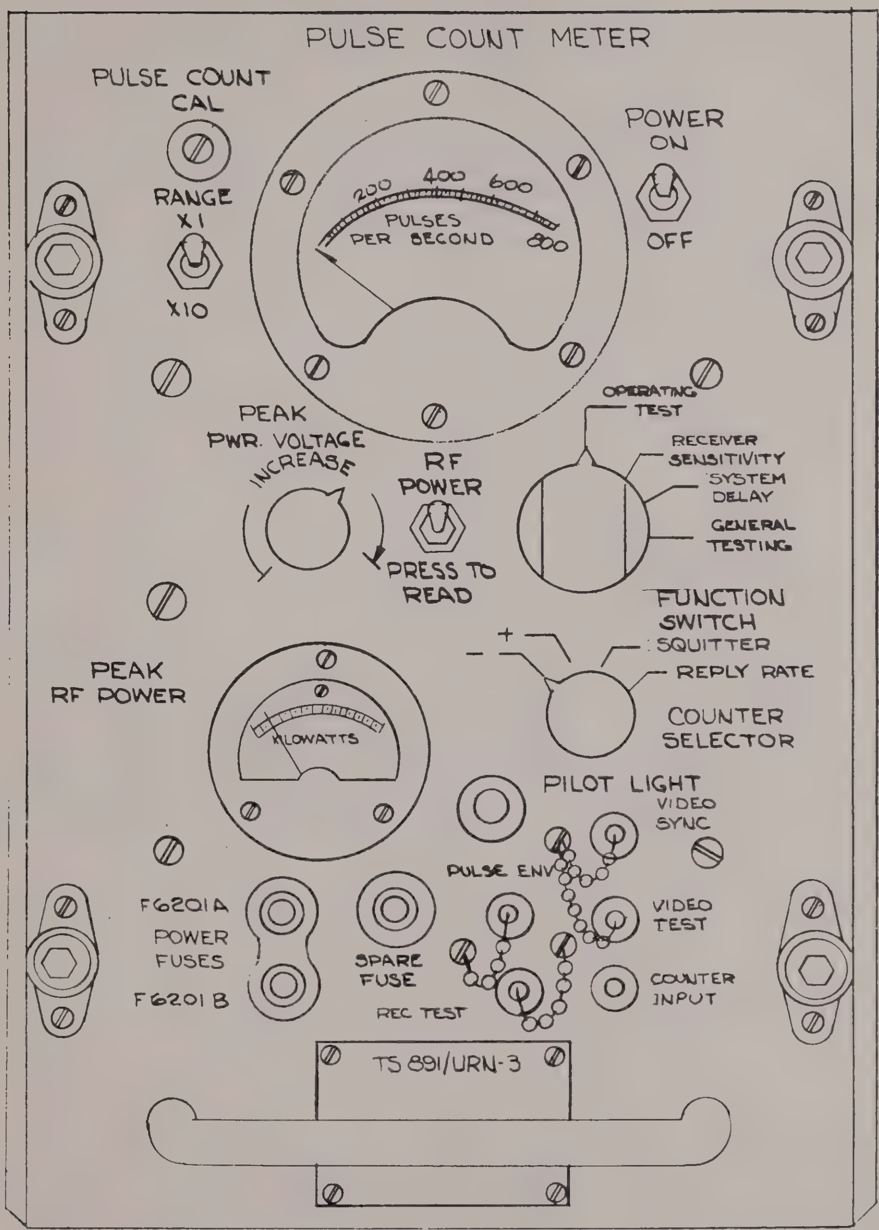


Figure 5-4. Power Meter-Pulse Counter TS-891/URN-3, Front Panel

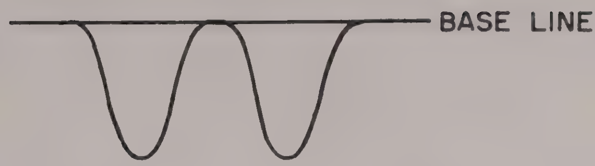


Figure 5-5. Transmitter Output RF Envelope, Use for Peak Power Measurement

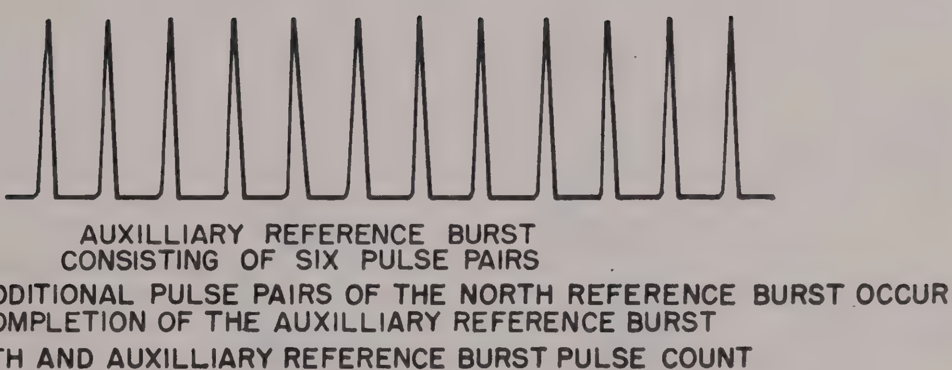


Figure 5-6. Composite Waveform, North and Auxiliary Reference Burst

Figure 5-7. Zero Distance Delay Measurement Waveforms

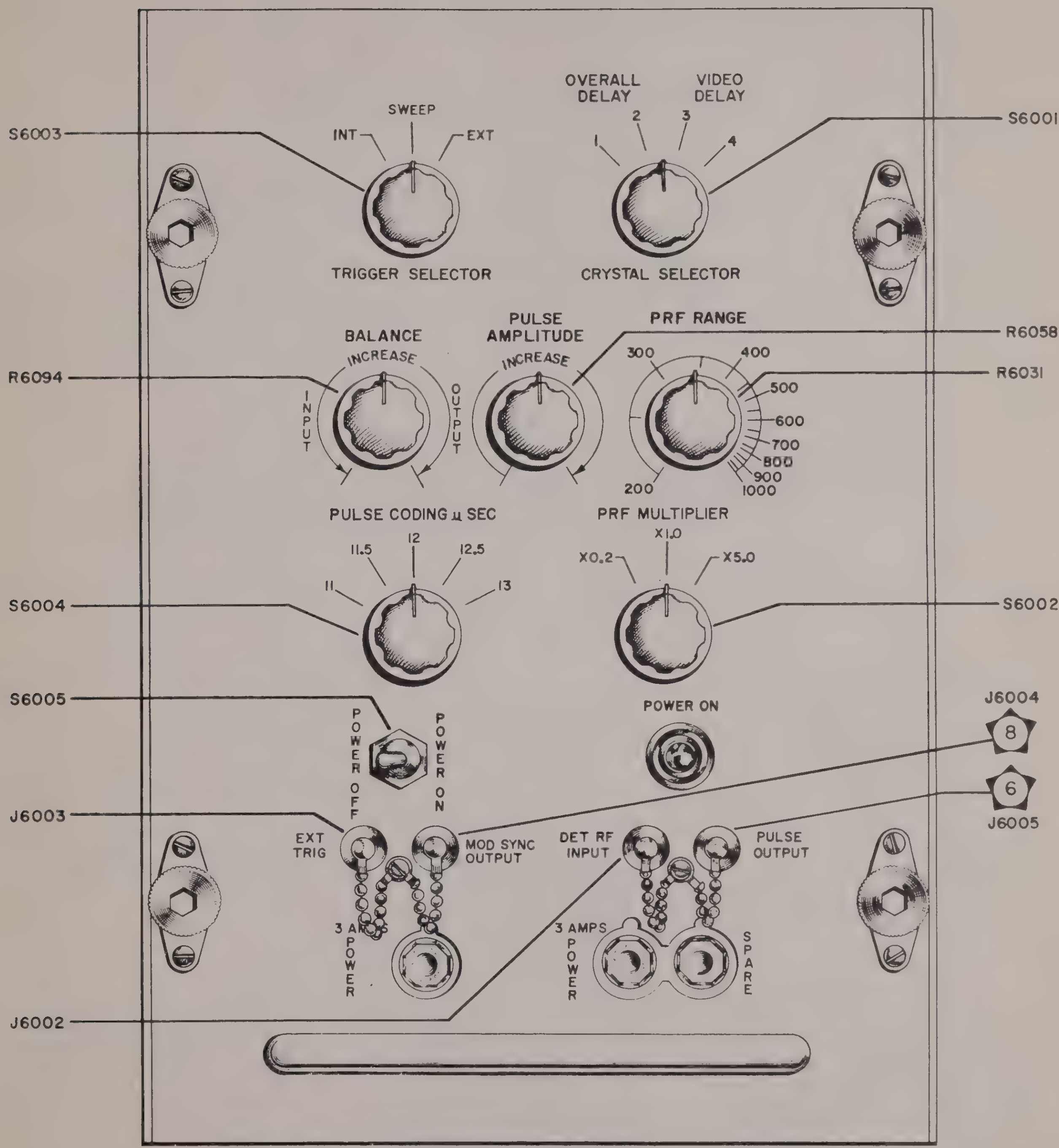


Figure 5-8. Pulse Sweep Generator SG-121A/URN-3, Front Panel

SECTION 6

PREVENTIVE MAINTENANCE

1. ROUTINE MAINTENANCE.

To assue continuity of service as well as peak performance of the radio beacon, this section provides the essential periodic routine mechanical and electrical checks and maintenance procedures. These procedures are included in table 6-1 following:

Note

THE ATTENTION OF MAINTENANCE PERSONNEL IS INVITED TO THE REQUIREMENTS OF CHAPTER 67 OF THE BUREAU OF SHIPS MANUAL OF THE LATEST ISSUE.

TABLE 6-1. ROUTINE MAINTENANCE CHECK CHART

DAILY CHECKS

WHAT TO CHECK	HOW TO CHECK	INDICATIONS AND CORRECTIVE ACTION
POWER DISTRIBUTION AND CONTROL		
Panel fuses. See figures 1-7 and 1-8.	Inspect all indicating fuseholders on the receiver-transmitter group cabinet and the power supply cabinet.	A glowing fuseholder indicates a blown fuse. Replace fuse.
Cabinet blowers. See figures 6-1 and 6-2.	Inspect the amber AIR SWITCH OPEN lamps on the amplifier-modulator (DS1303), the panel of the blower. compartment of the receiver-transmitter cabinet (DS901), and the blower and transformer compartment of the power supply cabinet (DS1001).	If one of the lights is lit, one of the blowers is not working properly. De-energize the equipment and repair or replace the blower. The blower filters should be cleaned in accordance with the procedure given in paragraph 2a.

TABLE 6-1. ROUTINE MAINTENANCE CHECK CHART (Cont'd)

WHAT TO CHECK	HOW TO CHECK	INDICATIONS AND CORRECTIVE ACTION
POWER DISTRIBUTION AND CONTROL (Cont'd)		
Control-duplexer front panel lamps	Inspect the blue MAIN POWER ON lamp DS1102.	If it is not lit, check for blown fuse. If a blown fuse is not found, refer to troubleshooting procedure in Section 7.
	Inspect the white FIL ON and ANTENNA CONTROL ON lamps DS1101 and DS1103, respectively.	Both lamps should be lit. If not, check to see that the switches are on; if they are, de-energize the equipment and refer to trouble-shooting procedure in Section 7.
Regulated filament transformer voltage.	Read the SUPPLY VOLTS meter, M1101, on the front panel of the control-duplexer.	Meter should read exactly 120 volts. If not, open the control-duplexer unit, manually close the interlock and loosen lock on the ADJUST FOR 120 V knob and adjust knob until voltage is correct, then tighten lock.
	Set the LINE-REG FIL BUS switch to LINE.	If the line voltage is not 120 v ±10%, refer to troubleshooting procedure in Section 7.
RADIO RECEIVER R-824/URN		
Panel lamps	Check the white POWER ON lamp DS501.	If the light is not lit, check the POWER ON switch on the radio receiver panel; if the switch is on, refer to the troubleshooting procedure in Section 7.
Voltages	Set METER SELECTOR switch to B+, 200 VFS.	Correct voltage is +150 ±5 volts. Full-scale deflection is equivalent to +200 volts; therefore, the meter should read 75 ±2.5 divisions on the

TABLE 6-1. ROUTINE MAINTENANCE CHECK CHART (Cont'd)

WHAT TO CHECK	HOW TO CHECK	INDICATIONS AND CORRECTIVE ACTION
RADIO RECEIVER R-824/URN (Cont'd)		
		calibrated scale. If the reading is incorrect, refer to the trouble-shooting procedure in Section 7.
	Set the METER SELECTOR switch to B- 200VFS.	Correct reading is 105 ±5 volts. The meter should read 52.5 ±2.5. If the reading is incorrect, refer to trouble-shooting procedures in Section 7.
	After ten minutes warmup, set METER SELECTOR switch to SQUITTER CONTROL -10 VFS.	Correct voltage is -5 ±1.0 volts (rapid 0.1 volt fluctuation is normal). Full-scale deflector is equivalent to -10 volts; therefore, meter should read 50 ±10 divisions on the calibrated scale. If it does not, refer to Section 7, troubleshooting procedures.
CODER-INDICATOR KY-235/URN		
Power	Inspect the white POWER ON lamp (DS601).	If the lamp is not lit, check the POWER ON switch on the coder-indicator panel; if the switch is on, refer to troubleshooting procedure in Section 7.
	Check to see that amber ANTENNA CONTROL lamp (DS602) is burning steadily.	Blinking of the lamp indicates trouble in the antenna control unit or the antenna. Refer to the troubleshooting procedure in Section 7.
Erection of antenna	Check to see that the SELECT ANTENNA POSITION	If necessary, reset switch to STOW position.

TABLE 6-1. ROUTINE MAINTENANCE CHECK CHART (Cont'd)

WHAT TO CHECK	HOW TO CHECK	INDICATIONS AND CORRECTIVE ACTION
CODER-INDICATOR KY-235/URN (Cont'd)		
	switch is in the STOW position for shore installations.	
Speed, azimuth, pitch and roll indicator readings with METER SELECTOR switch in each position.	Check to see that the speed, roll, pitch, and azimuth error readings are not steady in the red portion of the ANTENNA SERVOS meter scale.	Trouble is indicated by a steady reading in the red portion of the meter scale when the ANTENNA POSITION SELECTOR switch is in the STABILIZED position. Refer to the trouble-shooting procedures in Section 7 for corrective measures.
Identification keyer (See figure 7-11.9.)	Check to see that the keyer motor and code wheel are rotating and that the keyer switch is operating smoothly.	If faulty operation is noted, refer to Section 7 for troubleshooting and replacement procedures.
Magnetic variation (shipboard only.)	As often as necessary, and at least daily, check that the proper value of magnetic variation is set.	Magnetic variation changes as the ship's position changes. Reset as necessary. (Refer to Section 4 for detailed instructions on setting the magnetic variation.)
POWER SUPPLIES		
Panel lamps (see figure 1-8)	Inspect the LV-MV READY and HV READY lamps on the low- and high-voltage power supplies respectively. Inspect the LV (DS1603), and -375 V	The LV-MV READY lamp (DS1605) should be lit after one minute of operation. The HV READY lamp (DS1902) should be lit after five minutes of operation. If lamps are not lit after proper time interval, refer to Section 7, troubleshooting. The LV, -375 V, and +700 V +1000V lamps

TABLE 6-1. ROUTINE MAINTENANCE CHECK CHART (Cont'd)

WHAT TO CHECK	HOW TO CHECK	INDICATIONS AND CORRECTIVE ACTION
POWER SUPPLIES (Cont'd)		
	(DS1601) lamps on the low-voltage power supply panel; the +700V +1000 V lamp (DS1801) on the medium-voltage power supply panel and the HV lamp (DS1901) on the high-voltage supply panel.	should light after one minute of operation, and the HV lamp should light after five minutes of operation. If the lamps are not lit after the proper time interval, refer to the trouble-shooting procedures in Section 7.
	Inspect the amber MV OVERLOAD lamp (DS1803) on the panel of the low-voltage power supply, and the HV OVERLOAD lamp (DS1903) on the panel of the high-voltage power supply.	If one or both of these lamps are lit, refer to troubleshooting procedure in Section 7.
Output voltages	Set the meter selector switch under the SUPPLY VOLTS meter on the frequency multiplier-oscillator to each of the indicated voltages.	If the meter readings are not within 2% of what the meter selector switch indicates it should read (except the +700V which, depending on load conditions, will give a reading between 700 and 900 volts), refer to troubleshooting procedure in Section 7.
TRANSMITTER		
Frequency multiplier-oscillator lamps.	Check the white CRYSTAL OVEN HEATERS lamps.	Whenever the EMERGENCY SWITCH, S901, is in the ON position, the OVEN lamp DS1403 should be lit.
		NORMAL lamp DS1402 will light when EMERGENCY SWITCH S901 is first turned to the ON position. After the

TABLE 6-1. ROUTINE MAINTENANCE CHECK CHART (Cont'd)

WHAT TO CHECK	HOW TO CHECK	INDICATIONS AND CORRECTIVE ACTION
TRANSMITTER (Cont'd)		
		crystal oven reaches operating temperature, the NORMAL lamp will switch off and on and the oven heater goes off and on to maintain proper oven temperature.
Frequency multiplier-oscillator tuning meter	Read tuning meter M1402 on the frequency multiplier-oscillator front panel in each position of switch S1402.	Note any variation from values given in log showing daily readings of all switch positions on this meter. If any readings indicate greater than 5% variation from readings, refer to troubleshooting procedure in Section 7.
Amplifier-modulator lamps	Check that the white FIL lamp DS1301 is lit.	The FIL lamp should come on as soon as the amber airflow switch goes out.
	On Radio Set AN/GRN-9 only, check that the red +700V lamp DS1302 is lit.	The +700V lamp should light when the HV lamp on the high-voltage power supply lights.
Klystron beam current	Read CHARGING CURRENT meter M1301 on the amplifier-modulator front panel.	For Radio Set AN/GRN-9 the beam current should be between 190 and 210 ma.
		For Radio Set AN/GRN-9A and AN/SRN-6, the beam current should be between 80 and 100 ma.
High-voltage power supply	Read HV SUPPLY meter on the amplifier-modulator front panel.	High voltage should be approximately 12, 000 volts ± 1, 000 volts. If the reading is incorrect, refer to troubleshooting procedure in Section 7.

TABLE 6-1. ROUTINE MAINTENANCE CHECK CHART (Cont'd)

WHAT TO CHECK	HOW TO CHECK	INDICATIONS AND CORRECTIVE ACTION
WEEKLY CHECKS		
RADIO RECEIVER R-824/URN		
Squitter count	Check the squitter rate once a week, after replacing any tube, or after repairing the receiver. For procedure refer to paragraph 2b.	
Receiver sensitivity	Check the receiver sensitivity once a week or after replacing any tube or repairing the receiver. Refer to paragraph 2c for procedure.	-93 db signal level for 60% reply to a properly coded interrogation signal.
CODER-INDICATOR KY-235/URN		
Coder-indicator output	Monitor coder-indicator output at the TEST OUTPUT jack on the coder-indicator front panel.	Waveform pattern illustrated in figure 6-4 should be obtained.
Output pulse count	Refer to Section 5, paragraph 6 for method of checking the output pulse count.	Output pulse count should be 7, 200 ±180 pulses per second. If pulse count is incorrect, refer to troubleshooting procedure in Section 7.
North reference burst pulse count and auxiliary reference burst pulse count	Refer to paragraph 2f for method of checking reference bursts.	North reference burst should consist of 12 ±1 pulse-pairs. Auxiliary reference burst should consist of 6 ±1 pulse-pairs. (See figure 7-13, waveform 24B.)
Frequency of the identification code signal	Refer to paragraph 6-2h for method of checking identification tone signal.	Nine identification tone pulse-pairs should occur between auxiliary reference bursts.

TABLE 6-1. ROUTINE MAINTENANCE CHECK CHART (Cont'd)

WHAT TO CHECK	HOW TO CHECK	INDICATIONS AND CORRECTIVE ACTION
CODER-INDICATOR KY-235/URN (Cont'd)		
Identification code keyer	Connect a set of headphones to the TEST OUTPUT jack on the front panel of the coder-indicator, and listen to the identification code.	Every 37 1/2 seconds the identification code should be transmitted.
FREQUENCY MULTIPLIER-OSCILLATOR		
Zero distance time delay	Refer to paragraph 2m.	Refer to paragraph 2m.
AMPLIFIER-MODULATOR		
Output pulse shape	Refer to paragraph 2j.	See figure 6-5.
Peak power output	Refer to paragraph 6i.	Peak power output should be at least 5 kw for Radio Set AN/GRN-9 or 7.5 kw for Radio Sets AN/GRN-9A and AN/SRN-6.
MONTHLY CHECKS		
Klystron CONTROL DUPLEXER output incident signal	Using Oscilloscope OS-54/URN-3, observe the signal at the KLYSTRON OUTPUT INCIDENT jack on the control-duplexer front panel.	Compare amplitude of signal with previously logged readings. (See figure 6-5.)
Klystron output reflected signal	Using Oscilloscope OS-54/URN-3, observe the signal present at the KLYSTRON OUTPUT REFLECTED jack.	Compare amplitude of signal with previously logged readings.

TABLE 6-1. ROUTINE MAINTENANCE CHECK CHART (Cont'd)

WHAT TO CHECK	HOW TO CHECK	INDICATIONS AND CORRECTIVE ACTION
AMPLIFIER-MODULATOR (Cont'd)		
Antenna incident signal	Using Oscilloscope OS-54/URN-3, observe the signal at the ANTENNA INCIDENT jack on the control-duplexer front panel.	Compare amplitude of signal with previously logged readings. (See figure 6-5.)
ELECTRICAL EQUIPMENT CABINETS		
Cabinet blower air filters O901, O902, and O1001	Open the blower compartments at the bottom of the receiver-transmitter cabinet and power supply cabinet and check the blower filter. (See figures 6-1 and 6-2.)	Clean the filter, if dirty, in accordance with paragraph 2a.
SEMIANNUAL CHECKS		
ANTENNA AND ANTENNA PEDESTAL		
	WARNING When checking antenna and antenna base, be sure power is turned off by means of S901 EMERGENCY SWITCH on receiver-transmitter cabinet.	
Pulser carriage assembly brush tension	Check brushes for proper tension on slip rings.	Replace overworn brushes. (See Section 7, paragraph 15.)
Servo gears (see figure 7-39.13.1)	Check meshing of gear teeth. Look for signs of burring, play and slipping.	Lubricate gears in accordance with figure 6-9. Replace any gear that is damaged and does not mesh properly. (See Section 7, paragraph 15.)

TABLE 6-1. ROUTINE MAINTENANCE CHECK CHART (Cont'd)

WHAT TO CHECK	HOW TO CHECK	INDICATIONS AND CORRECTIVE ACTION
CODER-INDICATOR		
Identification keyer	Check that keyer meter and code wheel are rotating and that the keyer switches are operating smoothly.	If contacts are worn, replace switches S604 and S607.
Magnetic variation subassembly		Coat all gears with grease in accordance with figure 6-7.
TRANSMITTER		
Relays K1001, K1101, K1103, K1603, K1803, and K1804	Remove the relay covers and inspect contacts. (See figure 6-8.)	Burnish contacts. Replace relay if contacts are badly worn or burned.
	Note Relays are of the hermetically sealed type and do not require servicing.	Note These contacts are of the silver alloy type and should not be filed or sandpapered.

2. PREVENTIVE MAINTENANCE PROCEDURES.

a. CLEANING BLOWER FILTERS IN ELECTRICAL EQUIPMENT CABINETS.

(1) Shut off the equipment and remove the front panel of the blower compartment.

(2) Remove the long threaded rod with a wing head which holds the filter in place. (See figure 6-13.)

(3) Remove the cylindrical filter. Clean the filter with a vacuum cleaner and wash in a solution of water and dishwashing compound SNSN-G-51-C-1576-100.

(4) Shake out excess water and let the filter dry.

CAUTION

Do not oil filters.

(5) Replace the filter in the cabinet.

b. CHECKING RECEIVER SQUITTER RATE.

(See figure 5-4.)

(1) Turn the FUNCTION SWITCH on Power Meter-Pulse Counter TS-891/URN-3 to position 2, RECEIVER SENSITIVITY.

(2) Set the COUNTER SELECTOR switch on Power Meter-Pulse Counter TS-891/URN-3 to the SQUITTER position.

(3) Set the RANGE SWITCH on the TS-891/URN-3 to the X10 position. The SQUITTER rate, as read on the PULSE COUNT METER, should be 2,700 ±90 pulses per second.

c. CHECKING REPLY COUNT (RECEIVER SENSITIVITY).

(1) Make preliminary setup of front panel controls as directed in Section 5, paragraph 3.

Note

Before proceeding, check that setting of INPUT ATTENUATION SELECTOR on Pulse Analyzer-Signal Generator TS-890/URN-3 is at a maximum workable attenuation so as not to load the beacon, and cause the squitter voltage to go positive. In a typical radio beacon a setting of 35 db is normal.

(2) Set MODULATION SELECTOR switch on Pulse Analyzer-Signal Generator TS-890/URN-3 PULSE position.

(3) Connect a coaxial test lead from the RF OUTPUT jack on Pulse Analyzer-Signal Generator TS-890/URN-3 to the RF INPUT jack on Control-Duplexer C-1226/GRN-9.

(4) Set FUNCTION SWITCH on Pulse Analyzer-Signal Generator TS-890/URN-3 to position 2, RECEIVER SENSITIVITY.

(5) Set COUNTER SELECTOR SWITCH on Power Meter-Pulse Counter TS-891/URN-3 to REPLY RATE.

(6) Set RANGE SWITCH on Power Meter-Pulse Counter TS-891/URN-3 to X10.

(7) Set PRF RANGE on Pulse-Sweep Generator SG-121/URN-3 (figure 5-8) to 1000 and PRF MULTIPLIER to X1.

(8) Set the PULSE CODING switch on SG-121/URN-3 for 12-microsecond coding.

(9) Advance the RF OUTPUT DBM setting on the Pulse Analyzer-Signal Generator TS-890/URN-3 (figure 5-2) until the reply count is reduced to 600. Since receiver sensitivity is defined as the signal required for a 60 percent reply rate, the reading on the RF OUTPUT DBM will be the receiver sensitivity. The minimum requirement is 60 percent of replies at 93 db.

(10) Test that the 12-microsecond acceptance decoder of the radio receiver is working properly by observing whether the reply rate remains the same for the 11.5-microsecond and 12.5-microsecond positions of the PULSE CODING microsecond switch, but does not remain the same for the 11-microsecond and 13-microsecond positions of the switch. The radio receiver decoder should pass pulse pairs with separations from 11.5 to 12.5 microseconds between the pulses of the pair, but should not pass pulse-pairs with spacings below 11 microseconds or above 13 microseconds.

(11) Repeat steps 7 through 9, changing the PRF RANGE setting to 200 and PRF MULTIPLIER to X1. The minimum requirement is 60 percent of replies at 93 db.

(12) Repeat steps 7 through 9, changing the PRF RANGE setting to 250 and PRF MULTIPLIER to X10. The minimum requirement is 60 percent of replies at 93 db.

d. CHECKING RECEIVER BLANKING TIME.

(1) Allow at least 10 minutes receiver warmup time.

(2) Connect the receiver TEST OUTPUT jack on the front panel to the oscilloscope EXT TRIG INPUT (figure 5-3). Use positive sync on the oscilloscope (OS-54/URN-3).

(3) Connect blanking TP9 to the vertical input of the oscilloscope. Test point TP9 is located on the radio receiver video chassis. (See figure 7-11.7.) Make the necessary adjustments on the oscilloscope to synchronize the blanking pulses. The total horizontal sweep should be between 50 and 100 microseconds.

(4) The blanking pulse should be visible. If necessary, adjust R443 to set the pulse duration at 40 ±2 microseconds. BLANKING TIME ADJUST control R443 is located on the radio receiver video chassis (see figure 7-11.7).

e. CHECKING THE RECEIVER LOCAL OSCILLATOR SIGNAL. - Set meter switch S501 on the receiver front panel to the CR201 and the CR202 positions. The meter should read half-scale deflection at each position. If necessary,

signal strength may be adjusted by moving the pickup probe on the V1504 tripler cavity in or out to obtain the optimum meter reading.

f. CHECKING 15- AND 135-CPS REFERENCE BURSTS.

Note

> Throughout this book, the pulses generated by the reference pulse generator are referred to as the 15-cps reference trigger pulses and the 135-cps trigger pulses. Consequently, the bursts which are generated by the coder-indicator are referred to as 15-cps reference bursts and 135-cps reference bursts. It will be noted, however, that the jacks on both the ship and shore antenna bases, and on the cable entrance box of the receiver-transmitter group electrical equipment cabinet are marked NORTH for the 15-cps reference trigger pulse and AUXILIARY for the 135-cps reference trigger pulse.

Check the operation of the 15-cps and 135-cps burst as follows:

(1) On Oscilloscope OS-54/URN-3, set the FUNCTION SWITCH to position 2, RECEIVER SENSITIVITY.

(2) The presentation shown in figure 6-4a should appear on the oscilloscope.

Note

> TRIGGER AMP. and SWEEP STAB controls of the oscilloscope may have to be adjusted to obtain figure 6-4a.

(3) Normal indication, as shown in figure 6-4a, is auxiliary reference burst pulse-pairs (heavy pulses) and 12 north reference burst pulse-pairs (light pulses). Five of the north reference pulse-pairs will be superimposed on the auxiliary pulse-pairs. A north pulse-pair should be visible, one pulse of the pair to the left, and one pair of the pulse to the right of the fourth and ninth auxiliary pulses. Seven more north burst pulse-pairs should be counted at the end of the auxiliary burst.

g. CHECKING OVERALL CODER-INDICATOR OUTPUT. - Activate the radio receiver and close switch S605. Check the overall operation of the coder-indicator by setting the oscilloscope sweep to approximately 100, 000 microseconds and synchronize the oscilloscope to the line frequency or with the voltage from the SYNC OUT jack on the panel of the coder-indicator.

A pattern should be obtained as shown in figure 6-4b. The heavy areas in the pattern indicate the reference bursts. There should be identification call or distance information between the reference bursts, depending upon the position of the keyer switch. This pattern is useful in determining the overall operation of the coder-indicator, and to insure that reference bursts are not missing.

h. CHECKING PEAK POWER. - Peak power delivered at RF OUTPUT jack J1155 on the panel of the amplifier-modulator must be 5.0 kw or greater. To make this measurement, proceed as follows:

(1) Set the FUNCTION switches on the oscilloscope and power meter pulse counter to position 1, OPERATING TEST.

(2) With radio beacon fully operative, observe the transmitter r-f envelope on the oscilloscope. It should appear as shown in figure 6-5.

Note that gain, sweep speed, and trigger selection controls on the oscilloscope are automatically set as required for this test by internal controls associated with position 1 of the FUNCTION switch. Adjustment procedures for these controls are described in the Technical Manual NAVSHIPS 92778 supplies with Oscilloscope OS-54/URN-3. The SCALE ILLUMINATION, TRIG AMP and SWEEP STABILITY controls, and the SIGNAL DELAY SELECTOR and MARKER SEL switches are the only other controls having any effect. These should be set, respectively, to the counterclockwise, 5,5, OUT, and OFF positions. If a stable sweep is not achieved with these settings, adjust the TRIG AMP and SWEEP STABILITY controls as required.

(3) Turn the PEAK PWR VOLTAGE control on the power meter-pulse counter completely counterclockwise to its minimum setting.

(4) Depress the RF POWER switch on the power meter-pulse counter and maintain it in that position while making the measurement.

(5) While observing the pulse envelope on the oscilloscope, turn the PEAK PWR VOLTAGE control clockwise, until the negative pulses just touch the base line. At this point stop advancing the control and read the r-f power directly in kilowatts, on the PEAK RF POWER meter. For Radio Set AN/GRN-9 the peak power output should be 5 kw or over. For Radio Sets AN/GRN-9A and AN/SRN-6 the peak power output should be 7.5 kw or over.

i. CHECKING VISUAL PULSE SHAPE.

(1) Set the FUNCTION SWITCH on Oscilloscope OS-54/URN-3 to position 1, OPERATING TEST.

(2) With Radio Set AN/GRN-9 fully operative, observe the r-f envelope on the oscilloscope. It should appear as shown in figure 6-5.

(3) Utilizing the 1-microsecond MARKER SEL switch on the oscilloscope measure spacing between pulses. Spacing should be 12 ±0.3 microseconds.

(4) Measure the pulse width at the half-amplitude points. The correct pulse width is 3.5 ±0.4 microseconds.

j. CHECKING THE OUTPUT PULSE COUNT.
(See figure 5-4.)

(1) Set the FUNCTION SWITCH on the power meter-pulse counter to position 1, OPERATING TEST.

(2) Set the COUNTER SELECTOR switch to +.

(3) Set the RANGE SWITCH to X10. The output pulse count with Radio Set AN/GRN-9 operating properly should be 7,200 ±180 pulses per second (3,600 pulse-pairs).

k. CHECKING THE OUTPUT PULSE SPECTRUM. - The built-in test equipment includes a sharply tuned r-f voltmeter (the analyzer portion of the Pulse Analyzer-Signal Generator TS-890/URN-3) which is used to compare side-band energy with center frequency energy for an accurate check of pulse shape. The test equipment is highly specialized for this purpose and no corresponding procedure using commerical test equipment is available. The test is made with the beacon operating under normal traffic conditions.

(1) Make preliminary setup of pulse analyzer-signal generator as directed in Section 3, paragraph 3.

(2) Remove the connection at the RECEIVER INPUT jack of the Pulse Analyzer-Signal Generator TS-890/URN-3.

(3) Place the MODULATOR SELECTOR switch of the TS-890/URN-3 to the CW position. Recheck that the INTERROGATE switch is in the OFF position; otherwise test interrogations will block out normal beacon traffic.

(4) Connect the RECEIVER INPUT receptacle on the front panel of the TS-890/URN-3 to the RF OUTPUT jack on the control-duplexer. Figure 6-5 illustrates correct beacon output pulses.

(5) Adjust the INPUT ATTEN. SELECTOR for a midscale reading (100) on the POWER COMPARISON INDICATOR. Allow the meter pointer to stabilize before continuing to subparagraph (6) below.

Note

If no reading is obtained on the POWER COMPARISON INDICATOR, check that the BAND SHIFT control is in ZERO position, and that the OSCILLATOR SELECTOR control is in either REF OSC or VFO.

(6) Vary the position of the BAND SHIFT control through its five positions. If the reading of the POWER COMPARISON INDICATOR remains at midscale or moves to a position less than midscale for the four BAND SHIFT positions, then the beacon pulse shape is within specified limits. If when going through the four positions of the BAND SHIFT switch the POWER COMPARISON INDICATOR shows a reading higher than midscale, then too steep a pulse is indicated and tuning of the beacon is required.

l. CHECKING ZERO DISTANCE DELAY.

(1) Set the FUNCTION switch on both the oscilloscope and the power meter-pulse counter to position 3, SYSTEM DELAY.

(2) Set the pulse-sweep generator INT-SWEEP-EXT switch to SWEEP and the PULSE CODING USEC switch to 12. Set the OVERALL DELAY-VIDEO DELAY switch to 1.

(3) Adjust Pulse Analyzer-Signal Generator TS-890/URN-3 to provide a modulated signal by following the procedure of Section 5, paragraph 3. At the completion of these steps, set the MODULATION SELECTOR to PULSE and set the RF OUTPUT attenuator to -35 DBM.

(4) Observe the display on the oscilloscope and, if necessary, adjust the controls in the top row for a clear presentation. Note that there are two sets of pulses displayed: the output pulse and a pair of rectangular reference pulses. Adjust the pulse-sweep generator BALANCE control so that both sets of pulses have equal amplitude. This should provide a presentation similar to that shown in figure 6-10a.

(5) If a pattern such as that shown in figure 6-10 is obtained (that is, with the AN/GRN-9 output pulse-pair to the left of the reference pulse-pair), the overall delay is less than 50.2 microseconds and the next step may be performed. If it is to the right, the zero delay is too great and must be adjusted.

(6) Change the switch setting on the pulse-sweep generator to OVERALL DELAY 2. Observe that the pattern is as shown in figure 6-10b. If not (that is, if the GRN-9 output is to the left of the reference pulse-pair), the zero distance delay is less than 49.8 microseconds and must be adjusted. Ideally, the AN/GRN-9 output pulses should be as much to the right of the reference pulse (switch position) as they are to the left (switch position 2).

Note

The delay error indicated by the above checks is magnified by the type of presentation used. The check is intended as an accurate, readable go-no-go gauge and should be so used.

m. AGING THE KLYSTRON. - A new klystron tube, or one that has been unused for three months or more, should be aged according to the procedures described in Section 3.

n. CHANGING CRYSTALS. - It may become necessary to change the frequencies used by the radio beacon. The procedure for installing a new crystal is described in Section 3.

3. TUNING PROCEDURE. - Detailed tuning procedure for the radio beacon is given in Section 3. Adjustments on all units should be performed after the equipment has been started. For proper operation, adjustments should be performed in the order indicated below:

a. ADJUST REGULATED FILAMENT VOLTAGE. - The filament transformer (T1102) should be adjusted to exactly 120 V (see figure 3-17). To do this, proceed as follows:

(1) Loosen the locking screw under the ADJUST FOR 120 V knob on the control-duplexer.

(2) Set switch S1106 to the REG position (figure 4-2).

(3) Turn the ADJUST FOR 120 V knob until 120 V is read on the SUPPLY VOLTS meter M1101 (figure 4-2).

(4) Tighten the locking screw.

b. TUNE CRYSTAL OSCILLATOR.

CAUTION

Shorting the interlock exposes 1,000 volts. The HV ON switch S1901 on the panel of the high-voltage power supply should be at OFF. Before proceeding with the tuning,

CAUTION (Cont'd)

be certain that the crystal oven is functioning normally. This will be indicated by the LOW light on the panel of the frequency multiplier-oscillator blinking on and off occasionally.

Set the selector switch, S1401, under the TUNING meter, M1401, to the OSCILLATOR position (see figure 4-5) and tune coil L1502, OSCILLATOR TUNING (see figure 3-25) for maximum grid current on meter M1401.

Note

Coil L1502 is tuned and locked by means of a special tool provided with the equipment.

c. TUNING FREQUENCY MULTIPLIER STAGES.

(1) Set meter switch S1401 to the 1ST DOUBLER position. Adjust L1503, 1ST DOUBLER TUNING, for maximum grid current, as read on meter M1401.

Note

Coils L1503 and L1509 are tuned and locked by means of a special tool provided with the equipment.

(2) Set the meter switch S1401 to the 2ND DOUBLER position (see figure 4-5), and tune the 2ND DOUBLER GRID TUNING coil, L1509, for a peak on the meter reading.

(3) Set meter switch S1401 to the 3RD DOUBLER position. Tune for peak deflection of M1401 by adjusting C1509.

(4) Adjust the three slotted shafts that protrude alongside the cathode lines of V1504, V1505, and V1506 to vary the tuning of the cavities. The V1504, V1505, and V1506 cavities are each tuned for maximum deflection of M1401 with the meter switch in the TRIPLER, AMPL, and INCID positions, respectively.

(5) Check tuning by setting meter switch M1401 to the REFL position and tuning the V1506 cavity for minimum deflection. This tuning point should coincide with the maximum deflection point for the INCID position. Record the meter reading for future reference.

Note

V1505 and V1506 are pulse-modulated so that the reading of the tuning meter M1401 will be dependent

Note (Cont'd)

not only on the r-f drive but on the voltage and duty cycle of the keying pulses. It may prove useful to check the tuning of the keyed stages with an oscilloscope. The procedure recommended is described below.

(6) Connect an oscilloscope (type OS-54/URN-3) to monitoring jack J1152, marked KLYSTRON INPUT INCIDENT and located on the front panel of the frequency multiplier-oscillator (figure 6-18). Terminate the lead to the oscilloscope in a load impedance of approximately 70 ohms. Connect the SYNC input of the oscilloscope to VIDEO INPUT jack J1350 on the front panel of the amplifier-modulator (figure 3-14).

(7) Check the tuning of the V1505 cavity for maximum amplitude of the pulses seen on the oscilloscope.

(8) Check the tuning of the V1506 cavity in the manner described above.

d. SETTING PRE-SELECTOR CAVITIES IN CONTROL D. - Set the duplexer in accordance with the data shown in table 3-4.

e. ADJUSTING RECEIVER POWER VOLTAGES.

(1) Set the RADIO REC POWER ON switch S502 in the ON position, and check that the POWER ON lamp DS501 on the receiver panel has come on (figure 4-3).

Note

Ten minutes of warmup time should be allowed after the POWER ON lamp DS501 is lit before adjustments are started.

(2) Set the METER SELECTOR switch S501, located on the front panel of the receiver in the B+, 200 VFS position. The meter should read 75.

Note

200 VFS on M1401 represents 200 volts full-scale deflection. Therefore, a meter reading of 75 represents a reading of 150 volts.

(3) Set the METER SELECTOR switch at C200 VFS. The meter should indicate 52.5.

Note

-200 VFS on M1401 represents -200 volts full-scale deflection. Therefore, a meter reading of 52.5 represents a reading of -105 volts.

f. SETTING SQUITTER CONTROL VOLTAGE.

(1) Set the switch at SQUITTER CONTROL, -10 VFS. The meter should read about five (half-scale deflection) when the local oscillator power is normal (1.0 ma) read on position CR201 or CR202. When no local oscillator power is available, the squitter voltage will be no less than four as read on the meter.

(2) Disconnect the local oscillator input signal at J502 (figure 7-11.6). The voltage read on the meter should be approximately (no less than) 4. Replace cable to local oscillator at J502.

(3) Check and adjust, if necessary, the squitter rate as described in paragraph 2b of this section.

g. PRELIMINARY TUNING OF KLYSTRON AND R-F CIRCUITS.

(1) Open the access door of the amplifier-modulator. (See figure 3-14.)

WARNING

The 12,000-volt terminals of the klystron are covered by a shield. This shield must be in place at all times when the amplifier-modulator is energized.

CAUTION

A new klystron tube, or one that has been used for three months or more, should be aged before proceeding any further. Refer to paragraph 2f of this section for the recommended procedure.

(2) Move beam voltage switch S1303 to position NORMAL.

(3) Set the transmitter HV ON switch to the ON position. The H.V. SUPPLY, located on the amplifier-modulator front panel, should read approximately 12 kv and CHARGING CURRENT meter M1301 should read approximately 190 milliamperes for a normal duty cycle (7,200 pulses per second). If necessary, adjust potentiometer R1318 (KLYSTRON BEAM VOLTAGE ADJUST) to obtain that reading.

Note

The charging current will not change with klystron tuning.

(4) Set the transmitter HV ON switch to OFF.

(5) Preset the klystron to the proper transmitter frequency. Refer to the special klystron chart provided with the klystron. It will be noted that this chart shows three curves, one for each of the three cavities, input, middle, and output. The transmitter frequency is the ordinate of the curve, and the spacing in thousandths of an inch between the inside surfaces of the flanges is the abscissa.

(6) Choose the proper transmitter frequency and record the proper spacing for each of the cavities.

(7) Check and readjust, if necessary, each of these cavities to the settings recorded, making use of the wrench provided for this purpose, and also an inside vernier caliper.

Note

It is very important that the flanges be moved parallel with each other when they are being tuned. This is accomplished by not turning any one nut more than a full turn before turning the others the same amount. Check the spacing with the calipers.

h. FINAL TUNING OF KLYSTRON AND R-F CIRCUITS. - Connect Oscilloscope OS-54/URN-3 to the monitoring jack J1154 on the front panel of the control-duplexer marked ANTENNA INCIDENT (figure 4-2). Set the transmitter HV ON switch S1901 to ON. If the presetting of the klystron has been done correctly, and the frequency multiplier-oscillator is properly tuned, an indication should be observed on the scope. Adjust each of the cavities for maximum output by turning the nuts nearest the operator. The input cavity should be maximized first, being sure to keep the flanges parallel. Disregard pulse shape during this operation. The pulse may appear distorted as shown in figure 3-19.

4. ANTENNA GROUP, CHECKS AND ADJUSTMENTS.

a. ANTENNA ROTATION SPEED CHECK. - Use the output of the fork-tuned oscillator circuit in the coder-indicator as a frequency stardard for checking the speed of antenna rotation. This speed of rotation should

correspond to 15 cps or 900 rpm. To check the speed of antenna rotation, it is necessary to compare the 675-cps tachometer output voltage with the 1, 350-cps frequency standard. The procedure is as follows:

(1) Connect a coaxial test lead from the 1, 350-cps reference input jack, J2104 (see figure 7-39.22), on the speed control preamplifier plate in the antenna control unit to the test oscilloscope VERT SIG INPUT terminal.

(2) Connect a coaxial test lead from tachometer test jack J2105 (also on speed control preamplifier plate) to the oscilloscope EXT SWEEP INPUT (horizontal input) terminal.

(3) Position the pattern in the center of the oscilloscope and adjust its amplitude by varying the gain controls.

(4) If the antenna is spinning at or near its proper frequency, a slowly moving or steady pattern of the figure 8 will appear on the oscilloscope screen. Any deviation from this frequency will result in excessive shifting of the pattern to the right or left side of the screen. Any deviation from this frequency will result in a continuous pattern of figures 8 shifting to one side of the oscilloscope screen. If this occurs, refer to Section 7 for corrective information.

Note

In most installations the antenna control unit will be mounted close enough to the radio set to enable test jacks on the built-in test equipment in the power supply cabinet to be connected to test jacks on the antenna control unit. Where the antenna control unit is located at a point beyond the reach of test equipment test leads, a portable version of Oscilloscope OS-54/URN-3 or equivalent will be required to perform the antenna speed control test.

b. ADJUSTMENT FOR MAGNETIC VARIATION (SHIPBOARD ONLY).

(1) Check the magnetic variation to see that the correct compensation for magnetic north has been set (figure 7-11.9).

Note

Depending on the geographical location of the ship, angular difference between magnetic north and true north must be compensated for. This is necessary

Note (Cont'd)

because the ship's compass is calibrated to true north, whereas 15 cps or the north reference for aircraft is oriented to magentic north.

(2) Rotate the dial lock of the magnetic variation subassembly fully counter-clockwise, until the main knob rotates freely.

(3) Set the required variation in degrees on the hairline of the dial. For variations west of true north the dial should be rotated toward increasing numbers, that is, from 0° up to 10°, 20°, etc. For variations to the east, the dial should be rotated from 0° (360°) down, that is, toward 350°, 340°, etc.

(4) Secure the dial lock.

5. REPLACEMENT OF TUBES AND FUSES.

a. REPLACEMENT OF FUSES. - All fuses used in the radio beacon are held in fuseholders which have neon lamps in their caps which glow when the fuse is blown. When any apparent improper functioning of the radio beacon occurs, the indicating fuses should be checked before proceeding with other tests (figures 1-7 and 1-8). For fuse locations, refer to table 5-2.

CAUTION

Never replace a fuse with one of higher rating unless continued operation of the equipment is more important than probable damage. Use spare fuses located adjacent to the faulty fuse. If a fuse burns out immediately upon replacement, do not replace it a second time until the cause of failure has been corrected.

b. REPLACEMENT OF TUBES. - To replace defective electron tubes, loosen the captive screws holding the particular unit in the cabinet and slide the unit out to its fully extended position. Use special wrench at bottom of power supply or receiver-transmitter cabinet.

WARNING

When the klystron tube in the amplifier-modulator is replaced, the klystron must be aged and tuned and the output of the final stage of the frequency multiplier-oscillator should be checked for peak output. When

Note (Cont'd)

replacing tubes, it may be necessary to retune the equipment. Refer to Section 3 for instructions on tuning, klystron replacement and klystron aging.

6. GENERAL CLEANING AND INSPECTION PROCEDURE.

a. CLEANING. - In addition to specific cleaning and inspection procedure outlined in the foregoing paragraphs, service personnel is directed to periodically inspect and clean each of the following units comprising the radio set at least twice yearly:

Control-duplexer, receiver, coder-indicator, frequency multiplier-oscillator, amplifier-modulator, low-voltage power supply, medium-voltage power supply, high-voltage power supply, antenna group, Oscilloscope OS-54/URN-3, Power Meter-Pulse Counter TS-891/URN-3, Pulse Analyzer-Signal Generator TS-890/URN-3, Pulse Sweep Generator SG-121A/URN-3, and Switch-Test Adapter SA-420/URN-3.

WARNING

Be sure to de-energize the equipment before proceeding with the steps outlined in the paragraphs that follow. Set the master power switch and the auxiliary power switch to OFF, and tag these switches to warn other personnel against turning them on while work is being done on the equipment. On the AN/SRN-6 only, power from the ship's gyro compass repeater and the stable element will be present in the coder-indicator. Before cleaning or inspecting the coder-indicator, have the electronics officer shut off the power from the gyro compass repeater and stable element.

General cleaning instructions are as follows:

(1) Using a vacuum cleaner or air hose (compressed air), remove all dirt and dust from the interior of each of the compartments. Excess dirt may be removed with a clean dry cloth.

(2) Use dry-cleaning solvent 140-F (SNSN 51-S-4718-10 for 5-gallon drum) to clean ceramic or glass surfaces, and high-voltage insulators. This solvent may also be used to clean or wash grease or oil from the transmitter-receiver and antenna components.

(3) With a clean, lint-free rag remove all dust and dirt from the ventilating louvers of the cabinet enclosure.

b. PRECAUTIONS IN CLEANING. - Dry-cleaning solvent and volatile mineral spirits such as paint thinner are inflammable, and should not be used near an open flame. A fire extinguisher should be provided when these materials are used. Furthermore, solvents evaporate rapidly and have a drying effect on the skin. If used without rubber gloves, they may cause cracks in the skin, and occasionally a mild irritation or inflammation. Use only in well-ventilated places. The use of gasoline or benzine for cleaning is prohibited.

c. INSPECTION. - The general inspection of each item is a check to see whether the item is in good condition. Inspection for good condition is usually an external inspection to determine whether the unit is damaged beyond safe or serviceable limits.

Inspect the following components as described:

(1) Inspect all lug and screw connections for tightness, and check that cables and leads are properly dressed, to prevent short circuits or strains on wires and lugs.

(2) Inspect resistors, capacitors, coils and transformers for evidence of overheating. Carbonized or discolored surfaces, as well as loss of potting compound, are indications of overheating.

(3) Inspect front panel knobs and switches to see that they are not loose.

(4) Inspect vacuum tubes, making certain that all tubes are properly seated in their sockets. Pay particular attention to tubes and socket connections in the amplifier-modulator, frequency multiplier-oscillator, and power supplies in shipboard installations.

(5) Inspect for rust and corrosion on metal surfaces. If rust or corrosion is detected, sand the area with emery cloth and touch up with varnish or paint. Do not use paint or varnish on or near switches or tube socket connections.

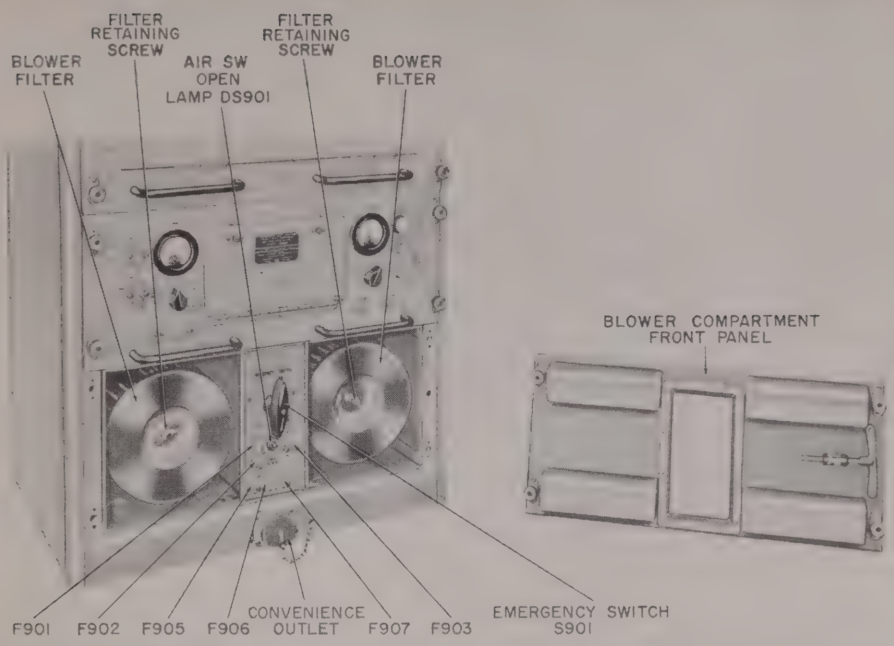


Figure 6-1. Blower Compartment, Receiver-Transmitter Group OA-1532/SRN, OA-1533/GRN-9, or OA-1534/GRN-9A

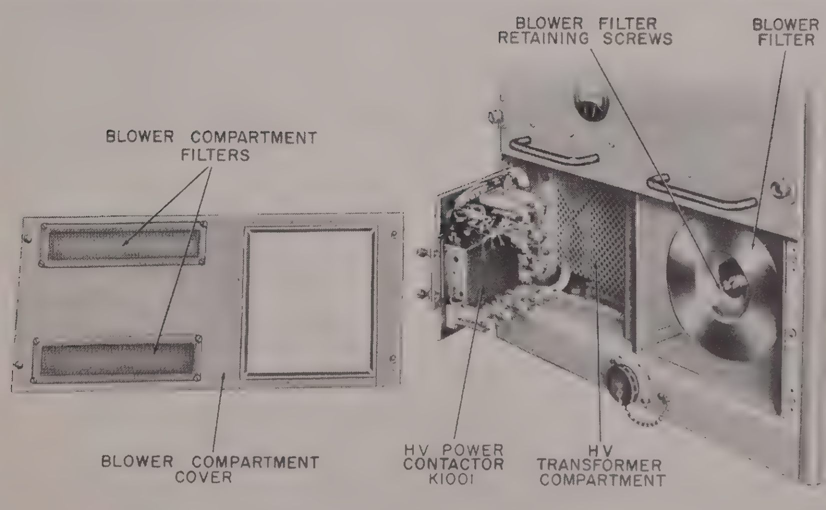


Figure 6-2. Blower Compartment With Front Panel Removed, Power Supply Assembly OA-1536/GRN-9, OA-1537/GRN-9A, and OA-1535/SRN-6

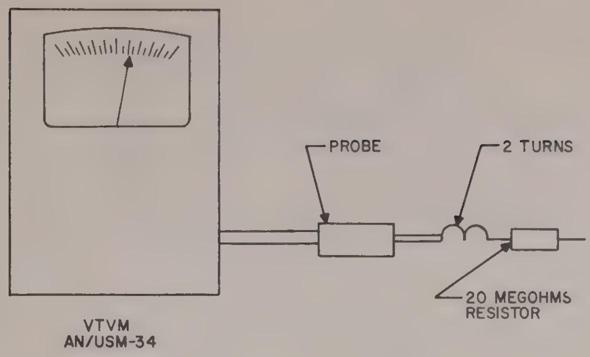


Figure 6-3. Special VTVM Test Probe

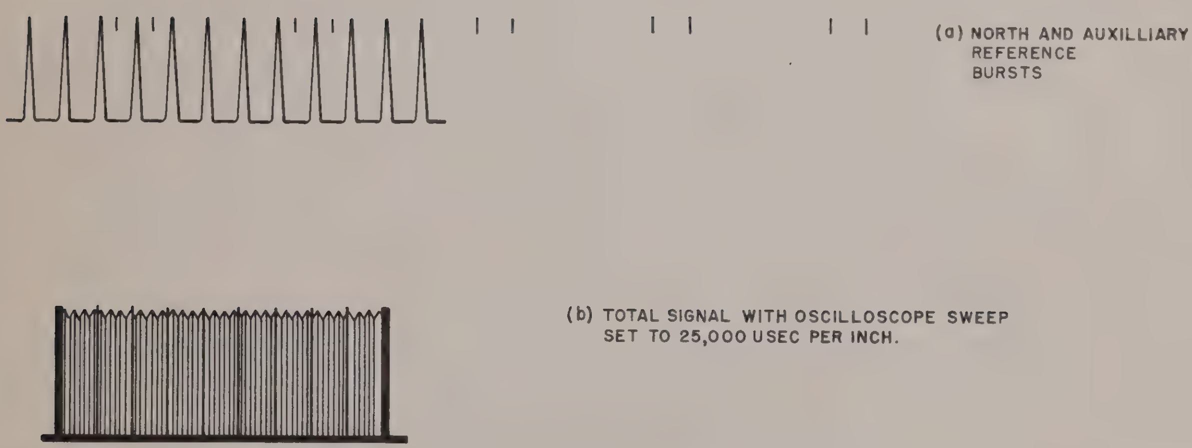


Figure 6-4. Waveshapes at Output of Coder-Indicator KY-235/URN

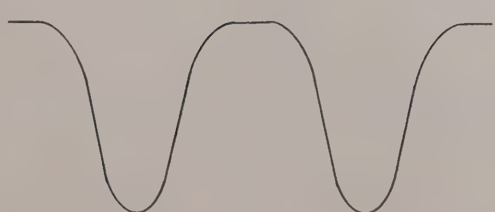


Figure 6-5. R-f Envelope, Transmitter Output

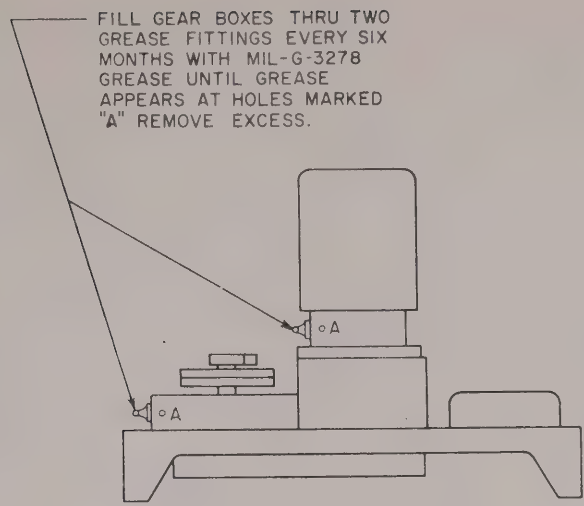


Figure 6-6. Coder-Indicator KY-235/URN Identification-Keyer, Lubrication Points

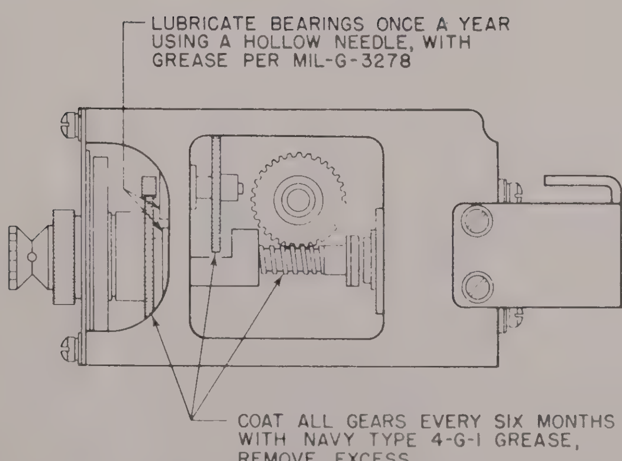


Figure 6-7. Coder-Indicator KY-235/URN Magnetic Variation Subassembly Lubrication Chart

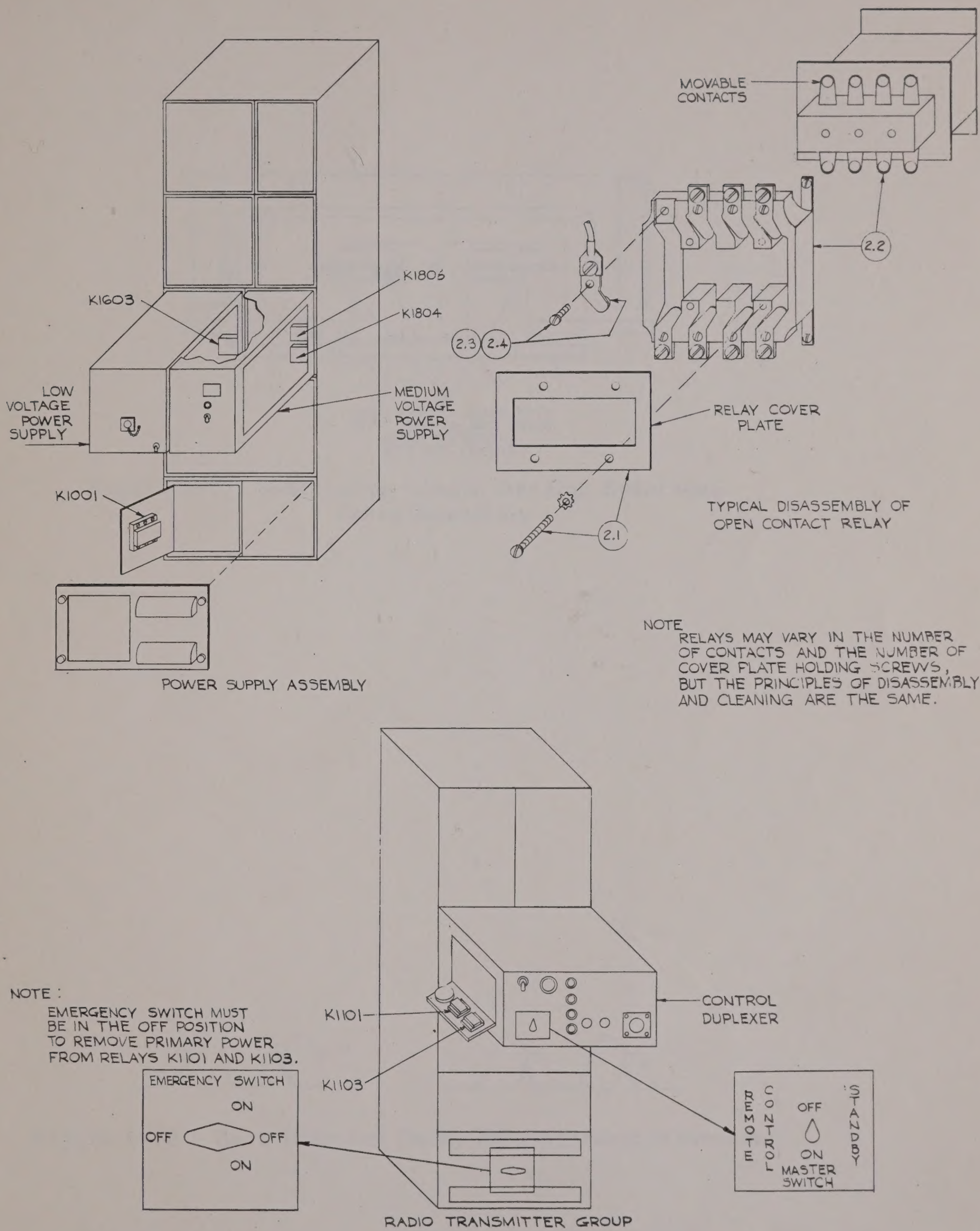


Figure 6-8. Location and Disassembly of Open Contact Relays

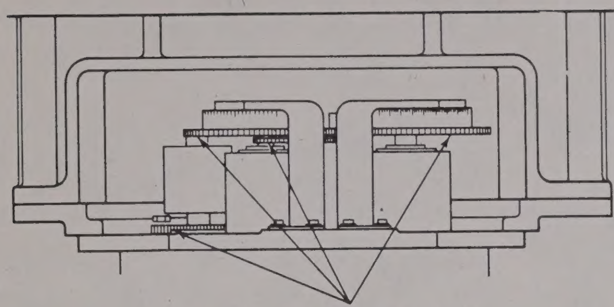


Figure 6-9. Lubrication Chart, Bearing Reference Servo Assembly

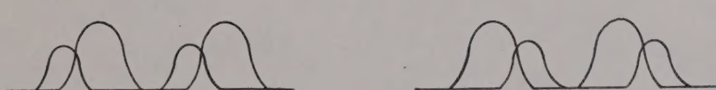


Figure 6-10. Zero Distance Delay Measurement Waveform

3 1 5 6 0/0 0 9